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THE

PHILOSOPHICAL MAGAZINE,

OR

ANNALS

OF

CHEMISTRY, MATHEMATICS, ASTRONOMY, NATURAL HISTORY, AND GENERAL SCIENCE.

BY

RICHARD TAYLOR, F.S.A. L.S. G.S. M. Astr. S. &c.

AND

RICHARD PHILLIPS, F.R.S. L. & E. F.L.S. &c.

"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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ALERE FLAMMAM

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Erratum.

P. 254 line 17 from the bottom, *for* low pressure *read* low temperature.

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

JANUARY 1829.

I. *A Sketch of the Topography and Geology of Lake Ontario.* By J. J. Bigsby, *M.D. F.L. and G.S., For. Mem. Amer. Phil. Soc. &c.**

[With a Map.]

General Remarks.

THE topographical part of this sketch of Lake Ontario has been drawn up with a sole view to the subsequent geological details. Statements having no reference to them I have therefore usually avoided. Whenever minuteness is employed, it is to introduce a new and important fact, or to correct error. I refer more immediately to the admeasurements of the shores and islands of the outlet; which an official situation I once held, allowed me to make from the maps of the Boundary Commission. The purposes of the commission not requiring a map of this lake, I have not a new one to offer:—the map accompanying these pages is taken from that of Purdy, published by Faden, and will answer the present exigency.

The whole circumference of the lake is occupied by prosperous agriculturists. Towns, villages, and hamlets innumerable, fill the fertile plains and undulations of its south borders, and especially in the neighbourhood of the small lakes. They are rising up on all sides with inconceivable rapidity: where the traveller of this year meets a wilderness, next year he finds a great village or self-styled city, full of inhabitants, receiving and distributing European merchandise with all the

* Communicated by the Author.

regularity of a Hanse town. As a natural consequence, this region has been visited and described in all its aspects, with great care, by numerous writers, among whom the most correct and copious are Spafford (Gazetteer), Darby (Tour to Detroit), Wright (Letters on America). The several Tourist's Guides for this district, published by Goodrich and others, booksellers of New York, contain much valuable information.

The northern or Canadian side of the lake has been examined with more or less attention by Bouchette, Hall, Gourlay, and others. Mr. Gourlay has contrived to comprise a vast accession of excellent matter, in a cumbrous and intemperate work (to say the least) on the statistics of Upper Canada. I have been frequently indebted to him in matters of topography. It is to be regretted, that hitherto travellers in the Canadas have contented themselves with delineations of the principal towns, and of a few fine points of natural scenery, swelling their descriptions with thrice-repeated histories and traditions; and have overlooked the intermediate spaces, less imposing or picturesque, perhaps, but very often more important in physical or geological geography.

Fully sensible of the superior commercial advantages of the south side of Lake Ontario, its fertility, and great and rapidly increasing population, I cannot withhold my admiration of the bland and luxuriant landscapes of the north, and the exceeding comfort and conscious independence of the inhabitants. I consider it at present a most desirable residence for an Englishman with a family and a small capital, whose expectations are moderate. The disposition and the actions of the British Government are most paternal towards its Canadian subjects. There are no tithes; and no taxes, with the exception of some trifling ones to meet the expenses of roads, the distribution of justice, and the payment of a few civil officers and the House of Assembly. English goods are imported under a duty of $2\frac{1}{2}$ per cent, in place of 25—80 as in the adjacent United States of America. Good parochial schools are established everywhere; and in the towns there are seminaries of a superior character for the more opulent. In fact, men of fair education are now to be found even in the most remote situations, nor are they inactive. They are projecting and forming canals in every part of the country. In 1824 two were in progress at the west end of the lake—one to open a steady and sufficient communication between Burlington Bay and the open lake—another to connect Lakes Erie and Ontario by ascending the parallel ridge at the 12-mile Creek, and then proceeding through the level country to Chippewa Creek. The last project is under the superintendence of Mr. Merritt

of

of St. Catherine's. Five British steamboats (besides sloops and schooners, and several American steamboats) navigate the lake, visiting with goods and passengers all the settlements, great and small, on the north shore. Many of these are now respectable towns, whose very names are scarcely known on the face of a map; while those of older date have grown out of knowledge, such as Kingston and Niagara. Among the former are Bath, Bellville, Cobourgh, Port Hope, Ancaster, and Grimsby. The great iron-works established at Marmora, by Mr. Hayes, have been of immense benefit to the country in many points of view. By way of encouragement the British Government at once purchased of him 14,000*l.* worth of pig-iron. The flour, I may add, of the Canadian side of Lake Ontario, now rivals that so famous of Genesee; and especially the produce of the mills of Mr. Henry. Hemp might be a staple article of export from Lake Ontario; but successive attempts to promote its cultivation, on the part of Government, have most unaccountably failed. Timber, and particularly oak-staves and pine-shingle, is sent down toMontreal annually in considerable quantities from the bay of Quintè. Intermittent fevers are frequent, but mild, on the north shore of this lake, while they are much more malignant on the south shore. This is the only disease with which Lake Ontario is visited in a manner at all remarkable.

Topography.

Lake Ontario is 290 miles distant from tide-water on the river St. Lawrence. It extends from longitude 75° 41′ to longitude 79° 7′, and from north latitude 43° 5′ to north latitude 44° 12′. It is bounded on the north by the Home, Newcastle, and Midland districts of Upper Canada; and on the south by the Niagara district of that province, and the northern part of the state of New York.

This lake is of a long oval shape, and tolerably regular in its outline excepting at its east end. It lies nearly east and west, a few degrees only to the north of east. Mr. Bouchette, a topographical writer of great merit, represents this lake to be 171 miles long, 59½ miles in its greatest diameter, (from Irondiquet Bay on the south to Presquisle on the north,) and 467 miles in circumference *. Its length may be said, in round numbers, to be five times its average breadth of 35 miles. The narrowest part is opposite the river Niagara, and is nearly 30 miles across. From this point to the place of greatest breadth the change is effected very gradually.

* Topography of Canada.

The depth of Lake Ontario varies very much, but is seldom less than three fathoms, or more than fifty, although in the middle, attempts have been made with three hundred fathoms, without striking soundings (Bouchette). The prevailing idea of its being every where of immense depth, is not correct. Its waters, taken at a proper distance from shore, are particularly transparent and well-tasted; but not so soft and suitable for the solution of soap as rain water. Its level has been ascertained by the commissioners for the construction of the western canal (Erie) of the state of NewYork, to be 231 feet above that of the Atlantic Ocean.

There is something which may be mistaken for tides in this and the other great lakes. "It is most perceptible in the bays and inlets, and is accounted for on the principle of the breeze, which under the influence of the sun's rays blows from the water upon the land in the day-time, and in the night subsides, and yields to a counter current from the land to the water. These breezes operate upon the water, which is thus impelled to and from the land. The effect is what is called the lake tide.

"In the Bay of Quintè the ebbing and flowing are very considerable, but various, in consequence of the swells produced by different winds in the open lake. At the mouth of the Nappannee river, they frequently make a difference of twelve or fourteen inches in the depth of the water, and boats and small craft, passing to and from the mills, conform to the alternate influx and reflux, which succeed each other several times in a day. A person residing in the neighbourhood told me, that in general the tide of Nappannee took about fifty minutes to flow, and a hundred minutes to ebb, and that the rise varied from fourteen to seventeen inches*." In connection with this subject Mr. Gourlay adds, what I have observed myself, that at Queenston Wharf, on the riverNiagara, there is a constant ebbing and flowing of one foot in a minute.

"At the Whirlpool, there is a tide of three feet every four or five minutes on the west side of the pool." A mile below this last place, at the old mill, I remarked a flux and reflux of a foot every three or four minutes; and on the same side of the basin, below the Falls, there is a similar rise and fall in the eddy, which is always running upwards in-shore. In these cases, I believe the local accumulations and subsidences of water to arise from the form of the bed and banks of the river.

* Gourlay: Statistical Account of Upper Canada, vol. i. pp. 115, 268. I also visited the Nappannee, and derived the same information from the occupant of the mills, as is inserted in the text. It was only fair to Mr. Gourlay, as the first reporter, to make use of his words.

They are very marked at the Falls of La Pluie, in the north-west Indian territory.

The height of land which contains what may be termed the basin of Lake Ontario and of its tributary streams, is attained gradually by undulations and ridges, and is seldom denoted by a distinct crest. It is irregular in its course, and is more distant on the south shore than on the north, where it is never more than forty miles from the lake; and this interval gradually contracts on the west, and is twenty-four miles broad at York (the capital of Upper Canada): it is scarcely seven at the head of the lake. The country it traverses on the north is chiefly wilderness, and has received but little attention, except on the margin of this body of water. From any central part of the lake, its north coast puts on the appearance of a bold continuous line of heights running east and west, and, as the spectator approaches, breaking into confused ridges and hummocks of woods. These, taken individually, are neither high nor rugged; but they are very numerous in some parts, while in others they are replaced by rolling country, usually of great fertility, but varying with its soil; which includes every admixture of clay, marl, and sand; each sometimes in large tracts of considerable purity and of great depth, as we learn from the channels of rivers. The woods east and west of York, called the "Pine Barrens," are examples of extensive deposits of fine sand; the vicinity of the river Nappannee is loaded with gravelly sand; and portions of Yonge-street, the upper parts of Smith's Creek, &c. with nearly pure red clay. The lower parts of the hilly country are often occupied by small lakes full of fish; they are either single or in chains, discharging by rivulets into Lake Ontario.

I can only make an approximation to the height of the ridge dividing the waters of Lake Ontario from those of the great streams and lakes on its northern side. Behind York, the ridge is not less than nine hundred feet above its surface, and it probably does not differ much elsewhere. That it is so great, we learn from the known difference in level between Lakes Ontario and Simcoe, amounting to 420 feet, and from the descent into the latter lake being particularly obvious, and taking place in two conspicuous ridges, the one six miles from it, and indicated by a line of pine-woods;—the other (apparently parallel) is twelve miles off, and is higher. It is called the "Oak Ridge." Their united elevation above Lake Simcoe, is by rough estimate, five hundred feet.

It is to be remarked, that after ascending, near York, a steep bank a mile inland from Lake Ontario, and another soon afterwards, the country from thence to the "Oak Ridge" above mentioned

mentioned (twenty-four miles across), is either so flat, or so various and frequent in its changes of level, that I was unable to perceive in it any sensible rise. The distance, however, is considerable, a much greater elevation might have taken place without my detecting it when unaided by instruments.

The country bordering this lake on the south is the granary of the United States, and possesses the ordinary features of eminently agricultural districts. Its undulations, except on the east, are only sufficient for drainage, and do not often deserve to be called hills. It contains some very large morasses; and fifteen to twenty-five miles south of the lake there are twelve pretty large collections of water, but still of a size vastly inferior to the Canadian chain. The names of the largest are Onsida, Cayuga, and Seneca. They are much admired for their rural scenery. Handsome towns and villages are scattered along their banks, and decked vessels and steamboats navigate their waters. The line of heights on the south, dividing the tributary streams of this lake from those of Erie, and of the rivers Ohio, Alleghany, Susquehanna, and Hudson, is very capricious in its course; and, occasionally entering the state of Pennsylvania, leaves Lake Ontario ninety miles to the north, as at the Genesee and Black rivers; but it approaches to within a few miles of that lake in the swamps above the heights of Queenston on the river Niagara.

Mr. Darby, in his Tour from New York to Detroit (p. 224), has traced the course of this line from west to east. It is only distinguishable by the direction of its water-shed. Respecting its elevation above Lake Ontario I have no data.

The steep ridge on the south, of uniform but moderate height, which to a spectator on the lake is so striking an object, skirting its shores from Burlington Bay to Niagara river, and which, from thence easterly, disappears under a low belt of woods, rising again about the Genesee to be continued for sixty miles down the lake side, has been named the "Parallel Ridge."—Governor Clinton of New York* has given the best description of it, as it occurs from the Genesee to Niagara, in the following paragraphs.—It runs "in a direction from east to west. Its general altitude above the neighbouring land is thirty feet, and its width varies considerably; in some places it is not more than forty yards. Its elevation above the level of Lake Ontario is perhaps 160 feet, to which it descends by a gradual slope, and its distance from that water is between six and ten miles.

"There is every reason to believe that this remarkable ridge was the ancient boundary of this great lake. The gravel

* Address to the Historical Society of New York.

with

with which it is covered, was deposited by the waters, and the stones everywhere indicate by their shape the abrasion and agitation caused by that element. All along the western rivers and lakes there are small mounds and heaps of gravel of a conical form, erected by the fish for the protection of their spawn: these fish-banks are found at the foot of the ridge on the side toward the lake; on the opposite side none have been discovered. All rivers and streams which enter the lake from the south have their mouths affected with sand in a peculiar way, from the prevalence and power of the northwesterly winds. The points of the creeks, which pass through the ridge, correspond exactly in appearance with the entrance of the streams into the lake. These facts evince beyond a doubt that Lake Ontario has receded from this elevated ground; and the cause of this retreat must be ascribed to its having enlarged its former outlet, or to its imprisoned waters (aided probably by an earthquake) forcing a passage down the present bed of the St. Lawrence." To this I have only to add, that the general height of this ridge appeared to me to be more than thirty feet above the adjoining land, at least in its western portions. At Lockport its height must be eighty to a hundred feet, and is made by two embankments with rounded edges and sloping fronts. The canal mounts the ridge at this point, as being that of least elevation in that vicinity, as I am informed, and from the ascent being greatly facilitated by a ravine which saves a good deal of excavation.

Mr. Comstock, an overseer on the canal, told me that after having removed the soil from the rock on the summit of the ridge, its surface was every where found to be grooved and channeled in a N.E. or E.N.E. direction. Hence, says Mr. C., Lake Erie once discharged by this outlet also. At Lewiston, seven miles from the lake, this River Niagara cuts through this ridge at its highest level of 370 feet. From this place the ridge proceeds in a series of gentle curvatures to the west end of the lake, to form the hilly district about Burlington Bay, whose most striking eminences are Flamborough and Burlington Heights. On its route westward it gradually approaches the lake, and at Grimsby is only a mile distant, and so remains as far as Stoney Creek, when a small departure from the lake shore takes place to the north-west.

In the space west of the Niagara this ridge is an abrupt and uniform elevation of about three hundred feet in height, surmounted by a tolerably level country, and having at its base a strip of rich low land whose north border is washed by the lake. It is commonly faced, and especially on the lower portions, by banks of red clay, sometimes pure, or of sand with a few

few boulders: sometimes these banks are of large size and two in number, but more usually they are cut up by torrents and rains into mounds and knolls; where they do not exist, the ridge is a steep slope of woods and pasturage, with here and there interrupted ledges of rock. At the village of Grimsby it is rendered very picturesque by being crowned at a saliant angle by a massive cliff resting on a slope of ruins, and half-buried in large elms and pines. At Stoney Creek the height subsides to 130 to 160 feet; but about half a mile behind it there is another, an upper ridge, continuous for some miles. It is most probably an offset from that below.

The flat beneath this ridge, or "Mountain," as it is called here, is not much above the lake at the west end; but in the middle and eastern parts it is in gentle swells, which are forty and eighty feet high at the foot of the ridge. They are cut through by numerous rivulets nearly to the level of the lake, and display a vast deposit of red clay and a good many boulders, and now and then some sand, of which there is a large bed near St. Catherine's, and therefore it still remains in the state of a pine-wood.

This is the most beautiful and most improved part of Upper Canada.

Having at some length described the position and magnitude of Lake Ontario, and the general features of its environs (excepting its outlet), I shall now point out the nature and form of its shores, rivers, and islands.

The margin of this lake, with few exceptions, is low, and consists chiefly of beaches lined with pebbles of limestone, which are sometimes washed up in ridges*, supported in the rear by low banks of soil, &c. Such is the shore in much of the middle part of the lake, both on the north and south sides. Banks of earth, clay, or ferruginous sand, full of primitive and other boulders, are also frequently submitted to the abrasion of the waves, as about Sodus on the south shore, and in the Bay of Quintè, &c. Six miles east of York these banks, consisting of fine sand, clay, and marl, rise to the height of 250 to 300 feet in precipices, fissured vertically when composed of the last two materials. At the angles of the indents into which the coast is broken, these precipices project into the lake in lofty needle-shaped pyramids, while the interior of the ravines and

* It is important to observe, that for many miles west of Presquisle on the north shore, and especially at the distance from it of ten miles, ancient beaches (fifty to four hundred yards from the present waters and ten to twenty-five feet above them) range in certain places in irregular parallelism with the lake border, in the form of long and large naked heaps or banks of sand and boulders, now deserted by the waters.

coves

coves displays a series of partially wooded slopes strewn with displaced masses; frequently a straight line of cliffs is formed, which have in their upper parts large triangular excavations at tolerably regular distances; so that with their sharp and formal outlines they resemble a row of houses with their gables to the street, as in Holland. I need scarcely remark that this scenery is very fine, especially when a break in the heights admits a view of the neighbouring hamlets, or of the pine forests.

This part of the coast is called the "Highlands of York," and is between seven and eight miles long. Eastward it sinks very gradually, while westward it recedes from the lake for about a mile, leaving a flat space of clay (blue and red intermixed with quartz pebbles), and then ranges parallel with its shore to Burlington Bay, as a high and steep bank of woods. On the east side of these "Highlands," the country on the lake side is for many leagues principally wilderness; whether, therefore, the lofty embankments from thirty to sixty miles from York are spurs from that range, I know not; but in that interval there are terraces,—either single, and then at least one hundred feet high; or several, mounting one behind another, which range in great curvatures along-shore, each appearing to have contained a bay. They now overlook a morass or dense wood.

For fifteen or sixteen miles west of Port Hope (sixty miles east of York) the immediate bank of the lake is clay, capped by loam or sand. Here the clay is in thin horizontal laminæ. About ten miles from Port Hope the banks are of loam filled with quartz boulders. The height of these banks is usually about twenty feet, and never exceeds eighty. Bounded by the great beds of alluvion between York and Port Hope, and thirty to forty miles from the former, the lake side is a mere morass, penetrating into the country in bays filled with reeds and rushes. The south side of the peninsula of Prince Edward is in this state. The south shore is also frequently swampy.

Ledges or platforms of rock are extremely rare between Presquisle and York; but they are frequent in other places, as in the Niagara district, Bay of Quintè, vicinity of Kingston, Sackett's Harbour, &c.

On the western half of Lake Ontario its shores are distributed into unimportant and shallow bays, having an earthy bank or low ledge of rock at the angles, and low grounds within. The sheet of water called Burlington Bay at the west end, is more properly a lake, separated from the main lake by a sandy beach extending five miles; from Saltfleet on the south, to Nelson on the south, with a small creek as an outlet.

The bays of York and Presquisle are the best, and almost the only harbours on the north shore west of Quintè Portage; and the mouth of Genesee River in the middle of the south shore, is the nearest port to Niagara, and yet is seventy-five miles from it. The small indentures are always shallow and obstructed with sand-bars, as also are the mouths of the rivers in all parts of the lake.

The eastern half of Ontario is much broken by bays and inlets; the largest and most remarkable being on the north side, called the Bay of Quintè. It is twenty miles from the east end of the lake, and is very singularly formed between the irregular peninsula of Prince Edward's County on the south, and the main of the Midland District on the north. Its length through its various windings is fifty miles, and the breadth varies from one to five miles. It has several arms in various directions, from two to six miles long. A neck of land twelve hundred yards across, part marshy and part of sand, separates its upper end from a round lagoon two miles in diameter, which communicates with the open lake by a shallow and very short breach in the sand bank which forms the south side of the lagoon. The distant hills of the main, the frequent and high cliffs which overhang its wide-spreading basins of water, occasionally diversified by woody isles, and surrounded by farms and villages, impart a great share of beauty to the bay of Quintè. The peninsula of Prince Edward is indented with coves and points, and contains on its south side two lakes distinguished as the "East and West Lakes," the first being twelve miles round, and the second, sixteen. They communicate with Lake Ontario.

The three bays adjoining Kingston at the north-east extremity of the lake are very small, but are of great importance as furnishing convenient and defensible harbours for ships of large burthen. As the geological appearances in their neighbourhood are of interest, I shall be somewhat minute in their topography.

Kingston is by much the largest and most regular town on Lake Ontario, and improves rapidly. It is placed close to the water, on a rough slope, on the west side, and at the entrance of the bay called Kingston Harbour, where the shore is bold and well adapted for the construction of wharfs. This harbour is used by steam-boats and merchant-vessels. It stretches up northerly for $1\frac{1}{3}$ mile, terminating about a swampy island called "Bell's Island," in a marsh four miles long, which receives the small stream named Kingston River. The bay is six hundred yards across opposite the town, and widens towards its bottom to twelve hundred. The land to the west

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and north of Kingston is uneven, but rather rolling than hilly. In the rear of the town, between it and a cluster of houses contiguous, called the "French Village," there is an elevated platform of naked limestone of many hundred yards square, deeply but irregularly fissured; and another smaller, east of a church, just below it. In fact, much of the neighbourhood is very bare, the soil being gravelly and thin.

Point Frederic or Navy Point, the end of the slightly elevated tongue of land constituting the east side of Kingston Bay, and almost wholly covered with dock-yards, naval storehouses, military barracks, and workmen's cottages, is at the same time the west side of Navy Bay, in which the vessels of war lie. It admits vessels carrying a hundred guns. It is 790 yards long, exclusive of a variable space of marsh at the bottom, and 324 yards broad, some distance within its two containing points Frederic and Henry (616 yards apart). Point Henry is the promontory on the east of this bay. It is about 150 feet high; and crowned with fortifications, descends to the water by a rough grassy slope, which ends in a low shattered cliff. The third and eastern of these coves (as they are comparatively speaking), Hamilton Bay, is a narrow culde-sac, bounded by rocky shores. A breach in its eastern side forms the "Batteau Passage" to Montreal, and the part cut off is "Cedar Island." The principal features of the vicinity are seen advantageously from Fort Henry. Westerly, close at his feet, the spectator has in panoramic detail the naval establishments of Point Frederic, and beyond them the neat town of Kingston, protected behind by tall pines. On his southwest is part of the open lake, bounded on the S.E. by large islands, and on the N.W. by the undulating forms and woods of the main. This beautiful sheet of water seems from this point of view to be closed in the extreme S.W. by Amherst Island, sunk deep below the horizon, at the mouth of Quintè Bay. Besides Garden Island near Point Henry, and Simcoe Island, it has in its centre the small spot of shingle called Snake Island, which immediately arrests attention by its diminutiveness, its one vigorous tree, and single house,—used as a telegraph station. Directing the eye south-east across a part of the outlet a mile and a half broad, it meets the extensive and low forests of Grand Island, with here and there a white dwelling on its shores. The view to the north-east is speedily closed beyond the cluster of houses called "Barrie Field" by groves of pines growing on high and rocky ridges.

On the south or New York shore, at this end of Lake Ontario, the most considerable bay is that of Sackett's Harbour, with its outer portions named Henderson's and Chaumont's

Bay, altogether about eight miles across and two deep*. It is in some measure land-locked by two large and some smaller islands. For further details I refer to Darby, as before quoted, and to Spafford's Gazetteer of the State of New York. Sackett's Harbour village bears from Kingston S. by E. twenty-five miles; but it is thirty-five miles distant by ship's course. Other harbours for small vessels on this shore between Sackett's and the River Genesee are Sodus and Oswego. The former is a fine capacious basin, embayed by a ridge curving from the western angle, and which almost surrounds the bay: the latter is on the River Oswego, which has at its mouth a bar over which large or heavily-laden vessels cannot pass.

The rivers of Lake Ontario are not very numerous nor large, with the exception of six. They issue from single lakes, or chains of lakes. I shall only notice those which I have visited myself, and which are referred-to in describing the geology of the lake.

The River Niagara will be treated of in a separate paper. The stream nearest in its dimensions is the Trent, situated rather more than three miles below the upper part of the Bay of Quintè and on its north shore. Its main branch rises in Rice Lake, a large and irregular body of water, connected with others called the "Shallow Lakes," extending towards Lake Simcoe. At the mouth of the Trent, Rice Lake is forty miles distant. The Trent flows rapidly over a shallow rocky and pebbly bottom, with many flexures, through a beautiful country of steep ridges and luxuriant dales, thickly interspersed in the lower sixteen miles with hamlets, pasturage, and corn-fields. It varies from fifty to two hundred yards in breadth, and is about three hundred yards across at its mouth. I had no opportunity of acquiring more accurate admeasurement. The banks of alluvion usually skirting rivers are here large and high, particularly about the lower parts of the river. I observed several low and woody islands in it. Between eighteen and twenty-two miles from Lake Ontaric it receives from the east the Crow or Marmora River, on which, sixteen miles from the Trent by the carriage road, are erected the large iron-works† of

* This is merely taken from the common maps.

† The land about the works is rough and hilly. Although there are several large terraces of naked limestone and ridges of primitive rocks, the greater part of this tract is provided with a plentiful and well watered soil, chiefly of red clay and calcareous loam. Its fertility is evinced by crops which might excite the envy of the agriculturist of any nation. The River Marmora just above the works is a hundred yards wide, and runs between two parallel ridges 200 to 250 feet high, and at the works about 250 yards apart; the base of the one on the north being within a few feet of the stream, while a flat, eighty-three yards broad, intervenes between it and the left

of Mr. Hayes. This stream is about fifteen miles long, and holds generally a S.S.E. course. It leaves Crow Lake (oval, one mile and a half long) at its S.W. end. This lake at its upper extremity receives the River Belmont, three miles and a half long, issuing from Belmont Lake *, which lies north and south, and receives two considerable streams; one from the north, and the other from the west. The northern stream communicates by portages with the Mississippi of the Ottawa River.

The Movin River, formerly called Myer's Creek, enters Quintè Bay at a marshy spot nine miles below the Trent. The thriving village of Bellville is placed a little within its mouth on the left bank, where it is rocky and dry, and overlooked by an eminence of sandy soil, on whose summit is a church. The river is about fifty yards broad, and so continues for several miles, undergoing at intervals petty descents. In the township of Marmora, twenty-five miles from Bellville, I found it much smaller; but still of considerable size, and traversing rapidly a wilderness of rocks and pines. Its source is still further north in Hog Lake.

left eminence, which has also an upper platform forty or fifty feet above the river, partly supported by a cliff. On these two levels are placed in a convenient manner two large furnaces, three coal-houses, a forge with two forge hammers (four fires, and eight workmen; the weekly produce being about five tons), grist and saw mills, tannery, counting-house, storehouses, blacksmiths' shop, stables, eight double houses in a row for workmen and their families, three dwelling-houses, school-house, casting-house, carpenters' shop, pot ashery, &c. The average number of men employed at the works in the summer is one hundred; but in winter one hundred and fifty may find employment. Each furnace is thirty-five feet in height, and at the top of the boshes eight feet in breadth. Each will carry a charge of about seventy-two hundred weight of ore and five hundred bushels of charcoal in twenty-four hours, yielding about two tons and a half of good iron. [The ore is prepared for the furnace by burning it in kilns and pounding. The principal flux made use of is limestone, which is found on the spot.] The peculiar properties of the metal are toughness and softness. The castings consist of potash kettles, mill-irons, hollow ware of all sorts, and pig-iron for the forges. Opposite the works there is a small cascade occasioned by a descent in the river, and by its contraction and obstruction by two oval islets. A dam has been thrown across here; raising the upper part of the river a foot, and increasing the descent of the cascade to fifteen feet, so as to form two mill races on the left side, the one working the forge and furnaces, and the other turns the grist-mill.

The gentlemen superintendant (to whom, and principally to Mr. Smith, I am indebted for the above information) have a commodious house in the rear of the works, near the top of the hill. That of Mr. Hayes is on the upper platform, not quite a quarter of a mile south-east. The clearances in the vicinity amount to two hundred acres, and there are nearly a hundred agricultural settlers within ten or twelve miles of the works (1824). This extensive establishment has been built for the purposes of working the beds of magnetic iron-ore mentioned in the section on the geology of Lake Ontario.

* As far as I know, its true situation is not represented on any map.

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The River Genesee enters the lake in the middle of the south shore. At its mouth, on the left sloping bank, stands the village of Charlottestown. It is here about two hundred yards wide, and varies a good deal on the way to the first fall, five miles from the lake. The banks (as we ascend) soon rise to the height of 80 to 120 feet, and continue to mount to the Falls, where they are 196 feet. They are usually steep, and covered with trees, especially cedar and hemlock, growing on ferruginous sandstone. The first fall is seventy feet high. The quantity of water is only great in spring; it is, however, very advantageously displayed, by dashing on two successive ledges, from which, arching beautifully, it loses itself in the wreathing spray which ever plays around the foot of the bare red rock. The walls of the chasm into which it falls are perpendicular, and dilate so as to give it the form of a horse-shoe. Large masses of debris occupy the base of these cliffs. A few hundred yards above this cascade is a second, only a few feet in height; and a short distance still higher up the river, a third ninety feet high, and passing in an unbroken and almost transparent curtain over a gracefully curving line of rocks. Like the other falls it is embellished by heights and foliage. This river rises in the hilly region on the north frontier of Pennsylvania.

The islands of Lake Ontario are all at the north-east end, and are only twenty in number, counting several very small ones; I exclude the patches of marsh and pebbles in Quintè Bay. I shall only mention some of the larger. Of these, by far the greatest is Amherst or Tonti Island, Grand Island more strictly belonging to the outlet soon to be described. Amherst Island is a mile and three quarters below the peninsula of Prince Edward, the interval being named "The Upper Gap," while the "Lower Gap," $3\frac{1}{2}$ miles broad, is included between the lower end of Amherst Island and the upper end of Simcoe Island.

Amherst is fertile, of moderate elevation, runs about S.W., and is $10\frac{1}{3}$ miles long. It is pretty compact. Its greatest breadth is $4\frac{2}{3}$ miles. Its mean distance from the Canadian main is $1\frac{2}{3}$ mile.

The greater or True Duck Island, $15\frac{2}{3}$ miles south-east from the east point of Prince Edward Peninsula, is $2\frac{1}{3}$ miles long and 1600 yards across where widest; but it is commonly much narrower. It belongs to Canada.

Stony Island, 2 miles or thereabouts* from the American Main, near Sackett's Harbour, is $3\frac{3}{4}$ miles long by an average

* The map of the Boundary Commission, from which these distances are measured, does not include the vicinity of Sackett's Harbour.

breadth

breadth of $\frac{3}{4}$ of a mile. It is remarkable for the narrow lake ($1\frac{3}{4}$ mile long) which it contains running parallel to its length. Great Gallop Island, $2\frac{1}{3}$ miles from Stony Island, is 4 miles long, with a mean width of one mile.

Grenadier Island, $4\frac{1}{2}$ miles about S.E. from "Long Point" of Grand Island, is $2\frac{1}{2}$ miles long by $1\frac{1}{4}$ mile broad.

[To be continued].

II. *Letter from* Captain Basil Hall, *R.N. F.R.S. L. and E. &c. inclosing a Communication from* Peter S. Du Ponceau, *Esq. of Philadelphia, On some Points connected with the Nature of the Chinese Language.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN a work which I published some years ago, I stated as a curious fact in the history of language, that while the inhabitants of China, Corea, and Loo Choo, all spoke different languages, they made use of one common written character; and consequently that the people of those countries, though ignorant of one another's dialects, immediately understood, respectively, what was meant when the thoughts of any one of them were reduced to writing.

I cannot recollect where I picked up the above notion; but I believed it to be a current doctrine amongst philologists, till I had the pleasure of making acquaintance with Mr. Du Ponceau, in the United States of America, who very soon satisfied me that I had unconsciously been the means of propagating error. He has since done me the kindness to send me his opinions on this interesting question; and I shall be very happy if by publishing his communication you will aid me in rectifying the mistake into which my ignorance of such subjects has led me.

I have only to add that Mr. Du Ponceau is President of the American Philosophical Society, and of the Athenæum at Philadelphia, and Corresponding Member of the Institute of France. I am, Gentlemen, yours, &c.

Dunglass, Dunbar, 25th Nov. 1828. BASIL HALL.

My dear Sir, Philadelphia, 7th July, 1828.

Our mutual friend Mr. Vaughan has handed to me your polite letter of the 29th ult. I was much surprised, and at the same time highly flattered to find that the few observations I took the liberty to make to you on the writing of the Chinese, when

when we last met at Dr. Gibson's, had left an impression on your mind; as I had no expectation, amidst the many objects with which you were surrounded in your peregrinations through this country, of leaving even a trace in your remembrance. It is therefore with great pleasure that I comply with your request in giving some further development to the ideas which I then threw out to you, and which derive all their value from your having thought them worthy to be kept in mind.

Having for many years devoted my leisure moments to the study of the philosophy of language, the Chinese idiom and its peculiar system of writing could not escape my attention. I was at first astonished at the wonders which are ascribed to this mode of ocular communication, which appeared to me to be greatly exaggerated, and I determined to pursue the subject as far as my means would permit me. The result of my investigations does by no means agree with the opinion that is generally entertained. I do not pretend to know the Chinese language; therefore those who have learned and consequently can read and understand it, have a great advantage over me in a discussion in which I attempt to controvert even the opinions of profound sinologists. I have, however, studied the elementary and other works which treat of that idiom, in order to acquaint myself with the curious structure of that language and the principles of its graphic system, and have possessed myself of a sufficient number of facts to enable me to form logical conclusions. This is all that can be expected of a general philologist; if it were otherwise, that science must be entirely abandoned, as it is impossible for any one man to know more than a very few of the unnumbered and perhaps innumerable languages that exist on the surface of the earth.

The general opinion which prevails, even among those who are the most proficient in the Chinese idiom, is that the system or mode of writing which is in use in that country, and which they call the *written* in opposition to the *spoken* language, is an ocular method of communicating ideas, entirely independent of speech, and which, without the intervention of words, conveys ideas through the sense of vision, directly to the mind. Hence it is called *ideographic*, in contradiction to the *phonographic* or alphabetical system of writing. This is the idea which is entertained of it in China, and may justly be ascribed to the vanity of the Chinese literati. The Catholic at first, and afterwards, the Protestant missionaries, have received it from them without much examination; and the love of wonder, natural to our species, has not a little contributed to propagate that opinion, which has at last taken such possession of the

the public mind, that it has become one of those axioms which no one will venture to contradict. It requires not a little boldness to fly in the face of an opinion so generally received, and which has so many respectable authorities in its support, and none against it but those of reason and fair logical deductions from uncontroverted facts. As you have, however, in a manner challenged me to produce the proof of my assertions, I do not hesitate to do it, in the spirit of humility which becomes me, and submitting the whole to your candour and better judgement.

This opinion has naturally led to that of the Chinese writing being an universal written language, conveying ideas directly to the mind, and which might be read alike in every idiom upon earth, as our numerical figures and algebraic signs are. This idea has been carried so far that some missionaries have wished that the Chinese *written language*, as it is called, should be cultivated through the whole world; for then, the New Testament, being translated into Chinese, all nations might read it, without learning the spoken idiom, and on a mere inspection of the characters*. And as a proof that this might be done, it has been alleged that the Japanese, Coreans, Cochinchinese and other nations could read Chinese books, without knowing or understanding the oral language of China. But these are not the only wonderful systems to which this opinion has given rise.

This writing having been formed, as is supposed, without any reference to or connection with spoken language, a question might naturally arise, which of the two was first invented. Nobody, to be sure, has ventured to say, that writing existed before speech; yet, if that proposition have not been directly advanced, I must say that sinologists have come very near to it. For instance, they affect to call the monosyllabic words of the Chinese language the *pronunciation* of the characters; which leads to the direct inference, that the words were made for the signs, and not these for the words. A justly celebrated French sinologist, M. Abel Remusat, does not, indeed, believe that a language was invented to suit the written characters after they were formed; but he supposes that some then existing popular idiom was *adopted*, to serve as a *pronunciation* to the graphic signs †. One step more, and hardly that, and written characters must have been invented before men learned to speak.

The English sinologists, Sir George Staunton, the Rev.

* Remusat: *Essai sur la Langue et la Literature Chinoise*, p. 35.

† *Mélanges Asiatiques*, vol. ii. p. 52.

Mr. Morrison, and others, represent the Chinese writing much in the same point of view, of which you may convince yourself by referring to their works. And by way of proof, it is every where repeated that Chinese writings are read alike by different nations who do not understand the spoken idiom.

No philosopher, that I know of, has yet attempted to reduce these vague notions to a rational standard. I have stated them candidly, as they appear in the works of the missionaries, travellers, and sinologists, and I must own that they never satisfied my understanding. I have taken great pains to come at the real truth, and I shall now proceed to state to you the result of my inquiries.

The Chinese language,—I mean, as it is spoken; for I do not call any writing a *language*, except metaphorically,—is, as you well know, monosyllabic; that is to say, every one of its syllables (with very few exceptions) is a word, and has a specific determinate meaning. In which it differs from our languages, which consist for the most part of unmeaning syllables, or of syllables which if they have an appropriate meaning, it has no connection with the words of which they make a part. Take, for instance, the word *con-fir-ma-tion;* the first and the two last syllables have no meaning whatever; the second, *fir*, by itself, means a kind of tree; but it has no relation to the word in which it enters. It is otherwise with the Chinese language; every syllable of it is significant, and is never employed but in the sense of its meaning. There may be compound words in the Chinese; but as in our words *welfare*, *welcome*, each of their component syllables preserve their proper signification.

Every one of these significant syllables or words has one or more characters appropriate to it, and every character has a corresponding word*. If two Chinese read the same book, they will read it exactly alike, there will not be the difference of a single syllable. Were it otherwise, the Chinese writing would be translated, not read: notwithstanding what the sinologists tell us of the beauty of the Chinese poetry and even of their prosaic style *to the eye;* it is certain that the metre and rhythm of their verses are addressed to the ear; their versification is measured, and their poetry is in rhyme; and they have also a measured prose†. All this is written in the pretended ideographic character, word for word, exactly as it is spoken, and no two readings can absolutely take place. It seems, therefore, evident, that the characters were invented to represent the Chinese words, and not the ideas which these represent, abstractedly from their verbal expression.

* Remusat: *Grammaire Chinoise*, p. 1. † *Ibid.* p. 171, &c.

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It is true, that in the grouping of characters to represent single words, the inventors have called to their aid the ideas which the words express. Thus the character which answers to the word *hand*, is grouped with those which answer to words expressing manual operations. But this was not done with a view to an ideographic language. It was merely an auxiliary means to aid in the classification of the numerous signs, which otherwise the memory could not have retained. The sinologists see great beauties in these associations, of which I am not competent to speak. I suspect, however, that there is in that more of imagination than reality.

Be this as it may, as the Chinese characters represent the words of the language, and are intended to awaken the remembrance of them in the mind, they are not, therefore, independent of sound, for *words are sounds*. It makes no difference whether those sounds are simple and elementary, as those which our letters represent, or whether they are compounded from two or three of those elements into a syllable. There are syllabic alphabets, like that of the Sanscrit and other languages, and it has never been contended that they do not represent *sounds*. And it makes no difference that the Chinese syllables are also *words*, for that does not make them lose their character of sounds. But on account of this difference, I would not call the Chinese characters a *syllabic*, but a *logographic* system of writing.

This being the case, it seems necessarily to follow, that as the Chinese characters are in direct connection with the Chinese spoken words, they can only be read and understood by those who are familiar with the oral language. I do not mean to say that they cannot be applied to other monosyllabic idioms (and they are, in fact, applied even to polysyllabic languages, as I shall presently show), I only contend that their meaning cannot be understood alike in the different languages in which they are used.

You very well know, my dear sir, how various are the forms of human languages. You know that even in the same language, there are not two words exactly synonymous; *à fortiori* it must be so in two different idioms. Take the word *grand*, for instance, which belongs both to the French and to the English languages. Though its general meaning be the same in both idioms, yet how strong are the shades which distinguish the ideas they particularly represent! Now let us suppose that England is in possession of a logographic system of writing. Will the character representing the word *grand* be clearly understood by a Frenchman who does not know the English oral language? Will an Englishman understand the

French character *j'aimerois*, without knowing the French mode of conjugating verbs? How would a Latin phrase be understood by an Englishman or Frenchman, merely by means of signs appropriate to each word? Our ideas, independent of speech, are vague, fleeting, and confused; language alone fixes them, and not in the same manner with every nation. Some languages take in a group of ideas and express them in one word; others analyse a single idea, and have a separate word for each minute part of which it is composed. Some take an idea as it were in front, others in profile, and others in the rear; and hence the immense variety of forms and of modes of expression that exists in the different languages of the earth. All languages abound in metaphors and elliptical modes of speech, which vary according to the genius of each particular idiom. In no language are these figures more frequent than in the Chinese, which is admitted to be elliptical in the highest degree, and is full of far-fetched metaphorical expressions. For instance, the grandees of the empire are called *the four seas* (*quatuor maria*), to express which the Chinese writing has two characters, one for *quatuor* and the other for *maria*, which is very distant from the idea of *superiority* or *greatness*. I ask how these characters can be understood or read in a language that has not adopted the same mode of expression? Again: the English phrase, "*I do not expect it*," is rendered in Chinese by "*how dare!*" and the sentence "*What you are alarmed about is not of much importance*," is thus expressed: "*You this one bother not greatly required**." It would be difficult to read this intelligibly in any language but the Chinese, or one formed exactly on the same model, and in every respect analogous to it. Nor could the corresponding literal English phrases be read intelligibly in Chinese, for want of similar turns of expression and grammatical forms.

A purely ideographical language, therefore, unconnected with spoken words, cannot in my opinion possibly exist; there is no universal standard for the fixation of ideas; we cannot abstract our ideas from the channel in which language has taught them to run: hence the Chinese writing is and can be nothing else than a servile representation of the spoken language, as far as visible signs can be made to represent audible sounds. I defy all the philosophers of Europe to frame a written language (as they are pleased to call it) that will not bear a direct and close analogy to some one of the oral languages which they have previously learned. It will be English, Latin, French, Greek, or whatever else they may choose; but it will not be an original written idiom, in which ideas

* Morrison's Chinese Dialogues, vii. 197.

will

will be combined in a different manner from those to which they have been accustomed.

This reasoning, you will say, may be perfectly correct; but what, if in spite of your theory, Chinese books are understood in Japan, Corea, and Cochinchina, even though the people do not understand the spoken idiom of China? This is, indeed, a pressing argument, but was the child born with a golden tooth?

It is a pretty well ascertained fact, that in Tonquin, Laos, Cochinchina, Camboje and Siam, and also in Corea, Japan, and the Loo Choo Islands, the Chinese is a learned and sacred language, in which religious and scientific books are written, while the more popular language of the country is employed for writings of a lighter kind. It is not therefore extraordinary, that there should be many persons in those countries who read and understand Chinese writing, as there are many among us who read and understand Latin; and many on the continent of Europe, and also in Great Britain, and the United States, who read and understand French, although it is not the language of the country. In many parts of the world there is a dead or living language, which from various causes acquires an ascendancy among the neighbouring nations, and serves as a means of communication between people who speak different idioms or dialects. Such is the Arabic through a great part of Africa, the Persian in the East Indies, the Chinese in the peninsula beyond the Ganges, and the Algonkin or Chippeway among our North-western Indians. This alone is sufficient to explain why Chinese books and writings should be understood by a great number of persons in those countries, and why they should smile at an *unlettered* foreigner, who cannot do the like. But it must not be believed that they read those writings as a series of abstract symbols, without connecting them with some spoken language. If their language be a dialect of the Chinese, varying only in the pronunciation of some words, and if it be entirely formed on the same model, there is no doubt but that the two idioms may be read with the same characters, as their meaning is the same in both; but if there is any material diversity between the two idioms, it is impossible that the Chinese character should be understood, unless the spoken language of China be understood at the same time; and this may be proved by well ascertained facts.

In Cochinchina, the language commonly spoken is a dialect of the Chinese, monosyllabic like the mother tongue, and formed on the same grammatical principles. In writing this language,

language, the Chinese logographic character is exclusively used; but it does by no means follow that a Cochinchinese book would be understood in China, or *vice versâ*. For although in both languages, each character represents a single word, yet the words so represented are not always the same in sound or in sense. Thus the character which in Chinese represents the word *tăn* (a plain), in Cochinchina signifies *dât* (the earth). The character *kin* (metal), in Cochinchinese is read *kim* (a needle); Chinese *y* (kettle), Cochinchinese *chi* (lead); Chinese *pŏ* (to land), Cochinchinese *bac* (silver)*. It is evident that the same book or manuscript could not be read or understood alike by a Chinese and a Cochinchinese.

I cannot omit here an observation which appears to me to be peculiarly striking. If the Chinese writing be really *ideographic;* if it represents *ideas* and not sounds,—how does it happen that the same character is used in different languages to signify things that have no kind of connection with each other; as for instance, the verb *to land*, and the substantive *silver?* It is difficult to think even of a distant metaphor that will apply to both these objects.

In Japan there are two languages in general use. The *Koye*, which is no other than the Chinese, with some variation in the pronunciation of the words, arising probably from the difference of the vocal organs of the two nations; and the *Yomi*, which is the most popular language, the former being devoted to religion and science. The Yomi is polysyllabic, and has declensions, conjugations, and other complex grammatical forms, which the Chinese has not. Therefore it cannot be written with the Chinese character *logographically*, any more than the Greek or Latin could: yet the Chinese character is used in writing that idiom. From a selection of those characters a syllabic alphabet has been made, which is in common use†. From a similar selection, says M. Remusat, the Coreans have made a monophonic alphabet of nine vowels and fifteen consonants ‡, with which they write their language. At the same time they can read and understand the Chinese, in which their sacred and scientific books are written.

We know very little of the language of the Loo Choo Islands. Father Gaubil (the French missionary) says, that they have three different idioms; others say that they speak a language compounded of the Chinese and Japanese. But little reliance is to be placed in these reports. It is probable that the Chi-

* White's Voyage to the China Sea. Boston: Ed. 1823.

† *Grammaire Japonaise de Rodriguez.*

‡ *Recherches sur les Langues Tartares*, p. 81.

nese

nese is read and understood there also as a religious and scientific language, or perhaps as an auxiliary means of communication.

I have said enough, I think, to show that if the Chinese writing is read and understood in various countries in the vicinity of China, it is not in consequence of its supposed ideographic character; but either because the Chinese is also the language or one of the languages of the country, or because it is learned, and the meaning of the characters is acquired through the words which they represent. Without a knowledge of these words and of their precise signification according to the genius, syntax and grammar of the language, it would be impossible to understand or remember the signification of the characters. If those characters could be read into languages which like the Yomi and the Corean differ in their forms from the Chinese, or in the meaning and sound of the words which the signs represent, they might be read alike in English, French, Latin, Greek, Iroquois, and in short in every existing idiom upon earth, which I think I have sufficiently proved to be impossible, according to the plainest deductions of simple logic.

I have been carried further by my subject than I intended; but as I do not believe that it has yet been presented in this point of view, I thought that I should not be sparing of a few words in order to make myself clearly understood. With what success I have made out my argument I leave you entirely to judge. At any rate, I rejoice in the opportunity which it gives me of expressing to you the sentiments of sincere respect and esteem with which I am, Dear Sir,

Your most obedient humble servant,

PETER S. DU PONCEAU.

Capt. Basil Hall, R.B.N. F.R.S. &c. &c.

New York, 14th July.

P.S.—Since my arrival in this town, whither I have come on an excursion of pleasure, I have been agreeably surprised to find, by an article in the Baron Férussac's *Bulletin des Sciences Historiques, Philologiques, &c.* for the month of March last, that the opinion I have expressed on the subject of the Chinese writing, begins to prevail among the learned of Europe. The article I allude to is a short notice (p. 258) by M. Champollion, the elder, of a work on the History of Philosophy, published last year at Bonn, by Mr. Windischman, a German writer, who, as usual, represents the Chinese character as a sort of *pasigraphy*, which may be read alike in every language. M. Champollion, very properly, combats this opinion, and observes (as I have done) that the Japanese, Cochinchinese, and other

other nations, have been obliged to modify that system of writing, to adapt it to their own languages. He adds, that the details of these alterations are to be found in a late memoir of M. Remusat, inserted in the 8th volume of the Memoirs of the Institute of France (Academy of Inscriptions and Belles Lettres), pp. 34–69. Thus I have the good fortune to have M. Champollion and M. Remusat on my side, to some extent, at least, though to *what* extent I cannot exactly tell, as the volume of the Memoirs of the Institute above referred to, has not yet reached this country, at least that I know of. I am very anxious to see it, as I have no doubt that the subject will have been treated in a very profound and scientific manner, by so able and learned a writer as M. Remusat. I beg leave to refer you to it, for further information on this interesting topic. P. S. D.

III. *On the Method of deducing the Difference of Longitude from the Latitudes and Azimuths of two Stations on the Earth's Surface. By* J. Ivory, *Esq. M.A. F.R.S. &c.**

I NOW proceed to deduce the consequences that result from the equations (A) at p. 433 of the last Number of this Journal. Conceive the planes of the meridians of the two stations on the earth's surface, to be prolonged to meet the sphere circumscribing the terrestrial spheroid, and, in the great circles of the sphere, take two points having the same latitudes with the terrestrial stations; let β' denote the arc of a great circle passing through the two points, and there will be formed a spherical triangle of which the three sides are $90°-\lambda, 90°-\lambda'$, β'; the angle opposite to β' will be ω the difference of longitude; and if we put μ for the angle opposite to $90°-\lambda'$, and μ' for that opposite to $90°-\lambda$, we shall have, by spherical trigonometry,

$$\frac{\sin\omega}{\tan\mu} + \cos\omega\sin\lambda - \cos\lambda\tan\lambda' = 0,$$

$$\frac{\sin\omega}{\tan\mu} + \cos\omega\sin\lambda' - \cos\lambda'\tan\lambda = 0.$$

Subtract these equations respectively from the equations (A) above cited; then

$$\mathrm{Sin}\,(\mu-m) \times \frac{\sin\omega}{\sin\mu\sin m} = \frac{\cos\lambda}{\cos\lambda'} \cdot e^2\,\Delta' Q$$

$$\mathrm{Sin}\,(m'-\mu') \times \frac{\sin\omega}{\sin\mu'\sin m'} = \frac{\cos\lambda'}{\cos\lambda} \cdot e^2\,\Delta\,Q.$$

* Communicated by the Author.

But,

But, $\frac{\sin \omega}{\sin \mu} = \frac{\sin \beta'}{\cos \lambda'}$, and $\frac{\sin \omega}{\sin \mu'} = \frac{\sin \beta'}{\cos \lambda}$; therefore,

$$\text{Sin } (\mu - m) = e^2 \cos \lambda \sin m \, \Delta' . \frac{Q}{\sin \beta'},$$

$$\text{Sin } (m' - \mu') = e^2 \cos \lambda' \sin m' \Delta . \frac{Q}{\sin \beta'}.$$

If we examine the equations (x), at p. 243 of this Journal for October last, it will readily appear that

$$\text{Cos } \lambda \sin m \, \Delta' = \cos \lambda' \sin m' \, \Delta .$$

In reality this equation is not rigorously exact in the case of two distant stations, since, in obtaining the equations x, it has been supposed that $a = \text{R}$ in the value of cos φ. If we go back to the principle of the investigation, we shall find this rigorous formula, viz.

$$\text{Cos } \lambda \sin m \, \Delta' \cos \phi = \cos \lambda' \sin m' \, \Delta \cos \phi',$$

φ and ϕ' being the angles of depression of the chord joining the stations below the respective horizons. We therefore obtain this exact equation, viz.

$$\text{Sin } (\mu - m) \cos \varphi = \sin (m' - \mu') \cos \varphi' ;$$

which shows that the two sines multiplied by cos φ and cos φ' fail of being exactly equal, because the common chord is not equally depressed below the two horizons. In order to judge of this point with precision, I have investigated the depression ϕ at the station of which the latitude is λ, as follows,

$$\text{Sin } \varphi = \frac{\gamma}{2a}\left(1 - \frac{e^2}{2} \sin^2 \lambda + e^2 x^2\right);$$

and, as we have a similar expression for sin ϕ', we obtain these values,

$$\text{Cos } \phi = \left(1 - \frac{\gamma^2}{4a^2} + e^2 \frac{\gamma^2 \sin^2 \lambda}{4a^2} - e^2 \frac{\gamma^2 x^2}{2a^2}\right)^{\frac{1}{2}}$$

$$\text{Cos } \varphi' = \left(1 - \frac{\gamma^2}{4a^2} + e^2 \frac{\gamma^2 \sin^2 \lambda'}{4a^2} - e^2 \frac{\gamma^2 x^2}{2a^2}\right)^{\frac{1}{2}}$$

From these expressions it appears that cos ϕ and cos ϕ' approach so near to equality that we may safely reckon sin $(\mu - m)$ and sin $(m' - \mu')$, which are always small quantities, equal to one another, in any position of the two stations on the surface of the globe. Thus we have generally,

$$\text{Sin } (\mu - m) = \sin (m' - \mu'),$$

$$m + m' = \mu + \mu'.$$

It is to be observed that the azimuths of which we are speaking, have nothing to do with any geodetical line on the surface of the spheroid, or with any spheroidical triangle. The azimuth

at either station is the horizontal angle contained between the meridian and the vertical, or plane perpendicular to the earth's surface, which passes through the other station. The azimuths m and m' on the surface of the spheroid become respectively equal to the spherical angles μ and μ', when $e^2 = 0$, and $x = 0$; but in every case, the sum of the first two may be reckoned equal to the sum of the other two. Applying now a well-known property of spherical triangles, we have this formula, for finding the difference of longitude, viz.

$$\text{Tan}.\frac{\omega}{2} = \frac{\cos\frac{\lambda-\lambda'}{2}}{\sin\frac{\lambda+\lambda'}{2}} \times \text{cotan}\,\frac{m+m'}{2},$$

which is a formula common to the sphere and to any spheroid of small excentricity.

Having cleared up this method of surveying, placed it on its proper foundation, and made it general in its application, we may now mention some other formulas derived from the same principle. I shall put f for the equal arcs $\mu - m$ and $m' - \mu'$; and as the arcs are small, I shall suppose them equal to their sines. Simplifying the value of f before given, we shall have these equations, viz.

$$f = e^2 \cos\lambda \sin m \times \frac{x}{\sin\beta'},$$

$$\frac{\mu-\mu'}{2} = \frac{m-m'}{2} + f$$

$$\frac{\text{Tan}\,\frac{\lambda-\lambda'}{2}}{\text{Tan}\,\frac{\lambda+\lambda'}{2}} \times \tan\frac{m+m'}{2} = \tan\left(\frac{m-m'}{2} + f\right).$$

Further, we have, $\dfrac{f\sin\beta'}{\cos\lambda\sin m} = e^2 x;$

and, by substituting this value in the equations (A), p. 433 of the last Number of this Journal, and transforming them as in the equations (B), we shall get,

$$\text{Tan}\,u = -\frac{1}{\sin\lambda\tan m}, \quad \tan u' = \frac{1}{\sin\lambda'\tan m'},$$

$$\frac{\cos(u+\omega)}{\cos u} = \frac{\tan\lambda'}{\tan\lambda}\left(1 + \frac{f\sin\beta'}{\cos\lambda\sin m\sin\lambda'}\right),$$

$$\frac{\cos(u'-\omega)}{\cos u'} = \frac{\tan\lambda}{\tan\lambda'}\left(1 - \frac{f\sin\beta'}{\cos\lambda'\sin m'\sin\lambda}\right).$$

We have now three different formulas for finding the longitude, of which one is a deduction from the other two; and, as they should all agree in giving the same result, they may serve as

as a means of verification, and of judging of the exactness and consistency of the data. These formulas may be of use, when the excentricity is given. But if the excentricity is sought, we must find f; and the least attention to the formula for f, will show that practically no dependence can be placed on the result obtained by it, more especially when $\lambda - \lambda'$ is very small: because a small change in $\lambda - \lambda'$, within the limits of the errors of observation, as half a second, will produce a great change in f, or will even make it vary from a certain value, to be double of that value.

It has been proposed to find the excentricity by what is called the equation of the geodetical line. But this equation is liable, even in a greater degree, to the objection of which we have been speaking. It is in reality very pliant and accommodating; for let us take the data as actually observed, and we will obtain by it a certain excentricity; but we have only to change the data a little, within the limits of the errors of observation; and the same excentricity will become zero, or any other quantity we please. It is asserted that, in the instance of Beachy Head and Dunnose, the compression is $\frac{1}{149}$, and that it can be no other. But if we calculate the length of the chord between the two stations, with the compression mentioned, the known length of the radius of the earth's equator, and the difference of longitude in the Survey, it will be found to fall short of the measured chord no less than 80 fathoms; which is a proof, if any proof were needed, how little reliance is to be placed on such computations.

In the Survey no use is made of the azimuths, except to find the difference of longitude. The degree perpendicular to the meridian is deduced from the length of the chord between the stations. But without computing the perpendicular degree, we may determine, directly from the difference of longitude and the chord, the dimensions of a spheroid that will represent the measurements both on the meridian and perpendicular to it. For, the difference of longitude being given, the arc β', which is the base of the triangle on the surface of the sphere, will be known; and, if a be the radius of the earth's equator, and γ' the chord of β', we shall have $\gamma' = 2a \sin \frac{\beta'}{2}$. Again, γ being the measured chord on the earth's surface, if we form the expressions of γ'^2 and γ^2 by means of the coordinates at the extremities of the two chords, and neglect the terms containing the powers of e^2, we shall get,

$$\gamma'^2 = \gamma^2 \left\{ 1 - \frac{e^2}{2} \left(\sin^2 \lambda + \sin^2 \lambda' \right) \right\} + 2e^2 a^2 x^2.$$

From this formula we obtain,

$$P = \tfrac{1}{4}(\sin^2\lambda + \sin^2\lambda') - \frac{a^2x^2}{\gamma^2}$$

$$e^2 = \frac{\gamma - 2a\sin\frac{\beta}{2}}{P\gamma},$$

in which e^2 and a are to be considered as unknown quantities. Now the length of a degree of the meridian, or which is better, any measured arc of the meridian, will give another equation between the same unknown quantities, which is sufficient to determine them both. It would serve no purpose to apply this method to the stations at Beachy Head and Dunnose, because it seems certain that there is a great error in the observed azimuths and the difference of longitude.

Taking the difference of longitude as in the Survey, and assuming the value of a as determined by the measurement of meridional arcs, in which there can be no great uncertainty, we shall find by the foregoing formula,

$$e^2 = \cdot 01807.$$

This is nearly three times the excentricity of the meridians; which seems so great an irregularity that we are forcibly led to suspect that the difference of longitude errs in defect, which makes the chord of the sphere too short, and, in consequence, e^2 too great.

On the other hand, if we make the difference of longitude $1^\circ\ 27'\ 5''\cdot 6$, which, there is reason to think, is not far from the truth, we shall then have,

$$e^2 = \cdot 00653,$$

which coincides with the excentricity of the meridian. In this case therefore the surface of the earth at the two stations would coincide with the figure formed by the regular revolution of the meridian about the earth's axis. Now it is very probable that this is nearly true; and it is confirmed by the exactness with which the same figure represents all the longitudes that have been accurately determined in the neighbouring region.

Dec. 13, 1828. J. Ivory.

IV. *On Interpolation*.*

(*From* Prof. Encke's *Astronom. Jahrbuch for* 1830, *p.* 265.)

INTERPOLATION means in general the proceeding by which is derived from the given numerical values of any function of a quantity, (or, according to astronomical language, an

* The substance of this paper is taken from the lectures of Prof. Gauss, which

an argument,) the value of this same function for any other given value of this argument, without knowing the form of the function, and even without the intention of knowing it. For this purpose Taylor's theorem is an auxiliary proposition, as it contains the general development of every function. By this theorem every function of a binomial quantity may be expanded into a series which has for its first term the function of the first part itself, and whose following terms proceed according to the powers of the second part, while the coefficients are formed from the derived functions or differentials of the first part. In order to render the series quickly convergent, the second part is usually assumed very small. In applying it to interpolation, it is therefore necessary to bring the value from which the result is to be derived as near as possible to the given one.

The cases in which Taylor's theorem ceases to be true, do not occur in interpolation, if this operation is only applied where it solely ought to be applied, viz. in cases in which the required numerical value of the function lies between the given ones, and in which the function within those limits becomes neither infinite nor impossible. In order to facilitate the explanation, let us assume that four values are given. The process may without difficulty be extended to any higher number. Let p, q, r, s denote the four values of the argument, and P, Q, R, S the corresponding values of the function. It is required to find the numerical value of the function X for the argument x.

We have by Taylor's theorem

$$f(a+\omega) = c + c_1\omega + c_2\omega^2 + c_3\omega^3 \ldots.$$

Assuming a as a value not much differing from x, and $\omega = x-a$, we have,

$$fx = \alpha + \beta(x-a) + \gamma(x-a)^2 + \delta(x-a)^3 \ldots.$$

where $\alpha, \beta, \gamma, \delta$ are unknown coefficients. For determining them we have these four conditions; viz.

for $x = p$ must be $fx = \mathrm{P}$
$x = q$ ——— $fx = \mathrm{Q}$ &c.

We have therefore these four equations:

$$\begin{aligned}
\mathrm{P} &= \alpha + \beta(p-a) + \gamma(p-a)^2 + \delta(p-a)^3 \\
\mathrm{Q} &= \alpha + \beta(q-a) + \gamma(q-a)^2 + \delta(q-a)^3 \\
\mathrm{R} &= \alpha + \beta(r-a) + \gamma(r-a)^2 + \delta(r-a)^3 \\
\mathrm{S} &= \alpha + \beta(s-a) + \gamma(s-a)^2 + \delta(s-a)^3
\end{aligned}$$

which I had the good fortune to hear in 1812. In the whole course of the development I have followed, as far as my memory served me, the steps of my much-esteemed preceptor, who combines the greatest strictness of reasoning with the greatest simplicity and elegance.

from

from which the four coefficients, and no more, may be determined by elimination. We obtain, therefore, only the terms of the expansion of fx, as far as that involving $(x-a)^3$, and the others must be assumed as evanescent. The elimination is clear, and requires no further explanation. Instead of investigating, however, the values $\alpha, \beta, \gamma, \delta$ for every single case, and substituting them in fx, another consideration will effect this purpose more concisely.

In looking at the process of elimination, it becomes at once evident how the values of $\alpha, \beta, \gamma, \delta$ must be with regard to the powers of P, Q, R, S. The equations being linear with regard to these quantities, P, Q, R, S will occur only in the first power in the expressions for $\alpha, \beta, \gamma, \delta$; but at the same time every term will contain one of these quantities as a factor. Accordingly, the form of $\alpha, \beta, \gamma, \delta$ will be generally this:

$$c\mathrm{P} + c_1\mathrm{Q} + c_2\mathrm{R} + c_3\mathrm{S}.$$

If these values are substituted in fx, fx will likewise contain no term without one of the quantities P, Q, R, S; or we shall have

$$\mathrm{X} = \pi\mathrm{P} + \chi\mathrm{Q} + \varrho\mathrm{R} + \sigma\mathrm{S}$$

where $\pi, \chi, \varrho, \sigma$ are coefficients, which, however they may be formed, can involve no higher power of x than the third, as the original equation contains none higher than $(x-a)^3$.

Applying now the conditions of the problem to this last form, we have evidently for

$x = p,$	$\pi = 1$	$\chi = 0$	$\varrho = 0$	$\sigma = 0$
$x = q,$	$\pi = 0$	$\chi = 1$	$\varrho = 0$	$\sigma = 0$
$x = r,$	$\pi = 0$	$\chi = 0$	$\varrho = 1$	$\sigma = 0$
$x = s,$	$\pi = 0$	$\chi = 0$	$\varrho = 0$	$\sigma = 1$

But if π is to be equal 0 for $x = q$, $x = r$, $x = s$, it is clear by the principles of algebra that it must contain the factors $x-q$, $x-r$, $x-s$; and if, as we have here supposed, q, r, s are different quantities, it must contain all three. In the other factors of π, x cannot be contained, because otherwise π would contain a higher power of x than the third. If we call, therefore, the product of the other constant factors of $\pi \ldots$ C, we have

$$\pi = \mathrm{C}\,.\,(x-q)\,(x-r)\,(x-s)$$

But by the first condition is $\pi = 1$ for $x = p$; consequently,

$$1 = \mathrm{C}\,.\,(p-q)\,(p-r)\,(p-s), \text{ or}$$

$$\mathrm{C} = \frac{1}{(p-q)\,(p-r)\,(p-s)}, \text{ and } \pi = \frac{(x-q)\,(x-r)\,(x-s)}{(p-q)\,(p-r)\,(p-s)}$$

The same reasoning applied to χ, ϱ, σ will lead to this general expression:

(I) X =

$$X = P\frac{(x-q)(x-r)(x-s)}{(p-q)(p-r)(p-s)} + Q\frac{(x-p)(x-r)(x-s)}{(q-p)(q-r)(q-s)}$$
$$+ R\frac{(x-p)(x-q)(x-s)}{(r-p)(r-q)(r-s)} + S\frac{(x-p)(x-q)(x-r)}{(s-p)(s-q)(s-r)},$$

which not only fulfils the given conditions, but is likewise the only one which does it completely, if there is no higher power of x than the third. For it is clear that the difference between any other expression not identical with (I), and the expression (I) must be $= 0$ for the four values $x = p$, $x = q$, $x = r$, $x = s$, and must consequently contain together the four factors $x-p$, $x-q$, $x-r$, $x-s$, or x raised to the fourth power, which is against our supposition.

The equation (I) may be expressed in a neater form if divided on both sides by $(x-p)(x-q)(x-r)(x-s)$. It will then become

$$0 = \frac{X}{(x-p)(x-q)(x-r)(x-s)} + \frac{P}{(p-x)(p-q)(p-r)(p-s)}$$
$$+ \frac{Q}{(q-x)(q-p)(q-r)(q-s)} + \frac{R}{(r-x)(r-p)(r-q)(r-s)}$$
$$+ \frac{S}{(s-x)(s-p)(s-q)(s-r)}$$

The form of fx being altogether arbitrary, we may assume for X, x^m, so that $P = p^m$, $Q = q^m$ &c. and our equation may be thus expressed: n quantities a, b, c, d being given (instead of the preceding x, p, q, r), and the mth power of each of them being divided by the product of all the differences between the quantity raised to the power and each of the others, the sum of all these n quotients is always $= 0$, as long as m is between 0 and $n-2$, both included. This latter restriction is necessary on account of the condition, that in deducing the series, the powers higher than x^3 should be excluded.

The investigation of the value of the series,

$$\frac{a^m}{(a-b)(a-c)(a-d)\ldots} + \frac{b^m}{(b-a)(b-c)(b-d)\ldots} + \frac{c^m}{(c-a)(c-b)(c-d)\ldots} + \text{&c.} \quad (A)$$

there being n quantities and the value of m arbitrary, leads to an estimation of the error of an interpolation. With this view we will expand in a twofold manner this fraction:

$$\frac{1}{Y} = \frac{1}{(y-a)(y-b)(y-c)(y-d)\ldots}$$

At first we will consider it as the product of the simple fractions $\frac{1}{y-a}$, $\frac{1}{y-b}$, $\frac{1}{y-c}$, &c. every one expanded separately, and then all multiplied together. As

$$\frac{1}{y-a} = y^{-1} + ay^{-2} + a^2y^{-3} \ldots .$$

$$\frac{1}{y-b} = y^{-1} + by^{-2} + b^2y^{-3} \text{ &c. we have}$$

$$\text{(B)} \qquad \frac{1}{Y} = y^{-n} + Ay^{-(n+1)} + By^{-(n+2)} + \ldots .$$

For our purpose it is unnecessary to know the values of A, B, &c. According to the doctrine of combinations they are for the $-(n+r)$th power of y, the rth class of combinations with repetitions formed of n elements; agreeably to Posselt's* notation, who has more closely investigated the series (A), it is $= {}^{r}(0)^{n}$.

If we dissolve, secondly, $\frac{1}{Y}$ into the sum of the partial fractions, whose denominators are respectively $y-a$, $y-b$, $y-c$, the well-known process shows that a, b, c, d, being all different, the numerators are obtained for each partial fraction by substituting in the product of all the other factors for y the value which makes the denominator of the partial fraction $= 0$. We have consequently

$$\frac{1}{Y} = \frac{1}{(a-b)(a-c)(a-d)} \cdot \frac{1}{y-a} + \frac{1}{(b-a)(b-c)(b-d)} \cdot \frac{1}{y-b} \text{ &c.}$$

Expanding again the fractions $\frac{1}{y-a}$, $\frac{1}{y-b}$, &c. into series, we have

$$\frac{1}{Y} = \frac{1}{(a-b)(a-c)(a-d)\ldots}\left\{ y^{-1} + ay^{-2} + a^2y^{-3} \ldots . \right.$$
$$+ \frac{1}{(b-a)(b-c)(b-d)\ldots}\left\{ y^{-1} + by^{-2} + b^2y^{-3} \ldots . \right.$$
$$+ \frac{1}{(c-a)(c-b)(c-d)\ldots}\left\{ y^{-1} + cy^{-2} + c^2y^{-3} \ldots . \right.$$

These quantities being summed up, the coefficients of the different powers of y are all series of the same form as (A). If we denote the sum of such a series by $[0]$, $[1]$ ..... $[m]$, according to the degree of the power to which the numerators of the fractions are raised, we shall have

$$\text{(C)} \qquad \frac{1}{Y} = [0]y^{-1} + [1]y^{-2} + [2]y^{-3} \ldots\ldots$$
$$+ [n-2]y^{-(n-1)} + [n-1]y^{-n} \ldots . + [n+r-1]y^{-(n+r)}$$

and the comparison of the coefficients of the same powers of y in (B) and (C) gives immediately in accordance with what was proved above,

* In his excellent dissertation: *De Functionibus quibusdam symmetricis. Auct.* Posselt. Göttingæ, 1818.

$[0] =$

$[0] = 0$, $[1] = 0$ ..... to $[n-2] = 0$. But we obtain likewise

$$[n-1] = 1, \text{ and generally } [n+r-1] = {}^{r}(0)^{n}.$$

The first result $[n-1] = 1$ is sufficient for our present purpose.

Let it be supposed that the complete expression for fx contained besides the terms employed, one of the fourth power $+\varepsilon(x-a)^4$ which would be the most considerable. P, Q, R, S being calculated from the complete expression would contain these additional terms $\varepsilon(p-a)^4$, $\varepsilon(q-a)^4$, $\varepsilon(r-a)^4$, $\varepsilon(s-a)^4$, and the expression (I) would, besides the terms arising from the lower powers, have this increment:

$$-\varepsilon.(x-p)(x-q)(x-r)(x-s)\left\{\frac{(p-a)^4}{(p-x)(p-q)(p-r)(p-s)}\right.$$
$$+\frac{(q-a)^4}{(q-x)(q-p)(q-r)(q-s)}$$
$$+\frac{(r-a)^4}{(r-x)(r-p)(r-q)(r-s)}$$
$$\left.+\frac{(s-a)^4}{(s-x)(s-p)(s-q)(s-r)}\right\}$$

The denominators of these fractions will not be changed if in these denominators the quantities x, p, q, r, s are all diminished by a, and consequently by the theorem just demonstrated the part inclosed in $\{\ \}$ will be

$$1-\frac{(x-a)^4}{(x-p)(x-q)(x-r)(x-s)}$$

and the formula (I) gives this value

$$X = \alpha+\beta(x-a)+\gamma(x-a)^2+\delta(x-a)^3$$
$$+\varepsilon(x-a)^4-\varepsilon(x-p)(x-q)(x-r)(x-s)$$

In reference to the 4th powers only, the error of interpolation, that is to say, that which is to be added in order to obtain the true value, is, therefore,

$$+\varepsilon(x-p)(x-q)(x-r)(x-s)$$

The conditions of the problem do not contain anything respecting the value of ε; but as the arguments for the interpolation may be chosen arbitrarily, the solution may be made in such a manner as to make the product

$$(x-p)(x-q)(x-r)(x-s) \text{ a minimum.}$$

This will clearly be the case if one of the values p, q, r, s is as near as possible to x, and the others distributed as equally as possible on both sides of it. If, for instance, it were required to interpolate for $x = 41\frac{1}{3}$, the error would be smallest by interpolating from the arguments 40, 41, 42, 43; viz. $= +\frac{40}{81}\varepsilon$; for 41, 42, 43, 44,

it would be $= -\frac{80}{81}\varepsilon$, and for the arguments 39, 40, 41, 42, it would be $= -\frac{56}{81}\varepsilon$; so that, independently of the sign, the ratio of the errors would be 10 : 20 : 14. This rule, that the values of p, q, r, s should always be so chosen that x is as nearly as possible equal to the mean of them, ought never to be neglected.

In single interpolations the formula (I) may sometimes be advantageously employed. It has the advantage that in case one of the quantities P, Q, R, S should be erroneous, one can see at once what influence this will have on the value of X. But it has the disadvantage, that in general it is not known how many terms P, Q, R, S will be sufficient, and be required for an accurate interpolation; and one is, therefore, not certain in individual cases whether the greatest accuracy has been attained. In order to facilitate this object, let the formula (I) be expanded into a series which successively proceeds from the use of two quantities to three, &c. Let the value of X derived from n quantities be X_n, we have

$$\begin{aligned} X_4 - X_3 = {} & S\,\frac{(x-p)(x-q)(x-r)}{(s-p)(s-q)(s-r)} \\ & + R\left(\frac{(x-p)(x-q)(x-s)}{(r-p)(r-q)(r-s)} - \frac{(x-p)(x-q)}{(r-p)(r-q)}\right) \\ & + Q\left(\frac{(x-p)(x-r)(x-s)}{(q-p)(q-r)(q-s)} - \frac{(x-p)(x-r)}{(q-p)(q-r)}\right) \\ & + P\left(\frac{(x-q)(x-r)(x-s)}{(p-q)(p-r)(p-s)} - \frac{(x-q)(x-r)}{(p-q)(p-r)}\right) \end{aligned}$$

or,

$$\begin{aligned} X_4 - X_3 = (x-p)(x-q)(x-r)\Big\{ & \frac{P}{(p-q)(p-r)(p-s)} + \frac{Q}{(q-p)(q-r)(q-s)} \\ & + \frac{R}{(r-p)(r-q)(r-s)} + \frac{S}{(s-p)(s-q)(s-r)}\Big\} \end{aligned}$$

In the same manner,

$$\begin{aligned} X_3 - X_2 = (x-p)(x-q)\Big\{ & \frac{P}{(p-q)(p-r)} + \frac{Q}{(q-p)(q-r)} \\ & + \frac{R}{(r-p)(r-q)}\Big\} \end{aligned}$$

$$X_2 - X_1 = (x-p)\left\{\frac{P}{(p-q)} + \frac{Q}{(q-p)}\right\}, \quad X_1 = P$$ because there can be no question of interpolation if one value only is given; $X_2 - X_1$ is nothing but the simple proportional part. The quantities inclosed in brackets are symmetrical functions of 2, 3, 4, quantities; and, as will be easily seen, without further demonstration, of five and more quantities. Each value of the function is divided in these expressions by the product of all the differences between the argument to which the functional value belongs, and all the other arguments. Let these expressions

sions be called *difference-quantities*, and denoted according to the quantities which are used for forming them by $[p.q]$, $[p.q.r]$ &c. The formulæ being symmetrical, $[p.q.r]$ and $[q.r.p]$ are identical, or the letters in these expressions may be arbitrarily exchanged one for the other.

By the addition of the different values, the formula (I) assumes the following form, which is more convenient for use:

$$X_4 = P + (x-p)[p.q] + (x-p)(x-q)[p.q.r] + (x-p)(x-q)(x-r)[p.q.r.s] \qquad (II)$$

The formation of the above *difference-quantities* will be most easily perceived by subtracting from each other two such quantities of the same dimensions containing the same elements but one. Thus, for example, $[q.r.s] - [p.q.r] =$

$$\frac{S}{(s-q)(s-r)} + R\left\{\frac{1}{(r-q)(r-s)} - \frac{1}{(r-p)(r-q)}\right\} + Q\left\{\frac{1}{(q-r)(q-s)} - \frac{1}{(q-p)(q-r)}\right\} - P\frac{1}{(p-q)(p-r)} = \frac{S}{(s-q)(s-r)} + \frac{R(s-p)}{(r-p)(r-q)(r-s)} + \frac{Q(s-p)}{(q-p)(q-r)(q-s)} - \frac{P}{(p-q)(p-r)} = (s-p)[p.q.r.s]$$

and it will be easily seen that generally

$$[q....yz] - [p....y] = (z-p)[p....yz]$$

If we conceive, therefore, these quantities, to which, for symmetry's sake, the quantities P, Q, R, S may be reckoned to be placed in the following manner,—

p	P				
		$[p.q]$			
q	Q		$[p.q.r]$		
		$[q.r]$		$[p.q.r.s]$	
r	R		$[q.r.s]$		$[p.q.r.s.t]$
		$[r.s]$		$[q.r.s.t]$	
s	S		$[r.s.t]$		
		$[s.t]$			
t	T				

each vertical column will be formed by subtracting a term of the preceding vertical column from the one below or the same column, and by dividing this difference by the difference of the arguments, to which diagonals drawn through the next higher and next lower quantities will point. For we have

$$[p.q] = \frac{Q-P}{q-p}$$

$$[p.q.r] = \frac{[q.r]-[p.q]}{r-p}$$

$$[p.q.r.s] = \frac{[q.r.s]-[p.q.r]}{s-p}.$$

In thus applying the formula (II) it will be always neces-

sary to interpolate downwards, and to have regard to the different signs. But it is more advantageous and more easy to interpolate from the middle, or from the place where x lies. In all formulæ we have not had reference to a definite arrangement; and we may adopt as the first, any other quantity besides P. For the arrangement R, Q, S, P, T the formula (II) becomes

$$X_4 = R + (x-r)\,[r\,.\,q] + (x-r)\,(x-q))\,[r\,.\,q\,.\,s] + (x-r)\,(x-q)\,(x-s)\,[r\,.\,q\,.\,s\,.\,p]$$

or changing the order of the letters:

$$X_4 = R + (x-r)\,[q\,.\,r] + (x-r)\,(x-q)\,[q\,.\,r\,.\,s] + (x-r)\,(x-q)\,(x-s)\,[p\,.\,q\,.\,r\,.\,s] \quad \text{(III)}$$

Comparing this to the above arrangement of the quantities, it will be seen that the *difference-quantities* here used $[q\,.\,r]$, $[q\,.\,r\,.\,s]$, $[p\,.\,q\,.\,r\,.\,s]$ are alternately above and below a horizontal line, which may be drawn between R and $[q\,.\,r]$. In like manner the arrangement R, S, Q, T, P would give this formula:

$$X_4 = R + (x-r)\,[r\,.\,s] + (x-r)\,(x-s)\,[q\,.\,r\,.\,s] + (x-r)\,(x-s)\,(x-q)\,[q\,.\,r\,.\,s\,.\,t] \quad \text{(IV)}$$

where the horizontal line must be drawn between R and $[r\,.\,s]$. Formula (III) is for the case in which x is between q and r. Formula (IV) for the one in which x is between r and s. Both expressions may be comprehended in one, by denoting all quantities which are on one side of x by a_n, a_{n-1}, ... a_1 a; among which let a be nearest to x; and those on the other side, by $b, b_1 \ldots b_{n-1}$ b_n, where b is supposed nearest to x. Supposing now that a is always the quantity nearest to x, and b more distant, both formulæ will become as follows:

$$X = A + (x-a)\,[a\,.\,b] + (x-a)\,(x-b)\,[a_1\,a\,b] + (x-a)\,(x-b)\,(x-a_1)\,[a_1\,a\,b\,b_1] + (x-a)\,(x-b)\,(x-a_1)\,(x-b_1)\,[a_2\,a_1\,a\,b\,b_1] \ldots \quad \text{(V)}$$

[To be continued.]

V. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 450.]

Genus 24. MACROGLOSSA, *Ochs., Steph.*

Macroglossum, Scop. — Sesia, Fab., Syst., Gloss.
Bombyliæ, Hübn. — Sphinx, Ochs.

Wings, small in proportion to the body; (elongate-lanceolate, opaque. Steph.)

Antennæ

Antennæ clavate; (gradually thickening nearly to the apex, which is scarcely attenuated: simple in the females. Steph.)
Palpi contiguous above the maxillæ, thickly clothed with scales. (Steph.)
Maxillæ as long as the *body;* the latter elongate, clothed with scales, tufted on the sides towards the apex and at the tip; (Steph.) broad at the hinder part.
Flight diurnal.
Larva elongate, slightly attenuated in front; caudal horn straight. (Steph.)
Pupa elongate, head-case produced. (Steph.)

A. *Margin of the wings entire.*

	Species.	Icon.
1. M.	*Fuciformis*, Linn.*	Ernst, III. Pl. LXXXIX. f. 117. e. f.—Curtis, Brit. Ent. I. Pl. XL.
2. —	*Bombyliformis*, Ochs.†	Ernst, III. Pl. LXXXIX. f. 117. c. d.
3. —	*Croatica*, Esp.	Hübn. Sphing. Tab. 18. f. 89. (mas.)
4. —	*Stellatarum*‡, Linn.	Ernst, III. Pl. LXXXIX. f. 116. a—e.

B. *Margin of the wings indented.*

5. —	*Oenotheræ*, Fab...	Ernst, III. Pl. CXXI. f. 166. a—i.
6. —	*Gorgon*, Esp.....	Hübn. Sphing. Tab. 21. f. 102.

CREPUSCULAR LEPIDOPTERA.

Genus 25. DEILEPHILA, *Ochs.*, *Steph.*

Sphinx, Fab., Latr. Spectrum, Scop.
Eumorphæ, Hübn.

Wings rather long, interior and exterior margin somewhat repand; (entire, the posterior slightly produced at the anal angle. Steph.)
Antennæ sub-filiform, (gradually but distinctly clubbed, especially in the males, the club attenuated at the apex and uncinated, with a naked subulated appendage, terminating in two slender hairs. Steph.)
Palpi contiguous above the *maxillæ*, which are rather elongated. (Steph.)
Head moderate, subovate; (Steph.) *eyes* large.
Body very acute, with a small tuft at the apex. (Steph.)
Flight crepuscular.
Larva various; *head* small; body smooth with lateral spots,

* Sesia.—*Steph.* † Sesia.—*Steph.* ‡ Macroglossa.—*Steph.*

generally

generally of lively colours; the anterior segments incapable of being withdrawn or expanded; or, without lateral spots, colours dull, the anterior portion of the body capable of elongation, and with lateral ocelli: *pupa* smooth, sheath of the maxillæ not exserted: changes in a loose leafy cell on the ground; or, subterranean. (Steph.)

Mr. Stephens divides this genus into two sections:

A. "*Anterior wings* not subfalcate, hinder margin rounded towards the apex: *abdomen* transversely banded: *antennæ* distinctly clavate. *Larva* maculated; anterior segments not retractile: caudal horn rugose: *pupa* superficially buried."

B. "*Anterior wings* very acute, subfalcate, the hinder margin having an emargination towards the apex: *abdomen* longitudinally striated: *antennæ* obscurely clavate. *Larvæ* not spotted, some of the anterior segments with a single large ocellus on each, and retractile; caudal horn smooth, sometimes nearly obliterated: *pupa* enclosed in a cocoon of leaves on the ground."—*Illust. Brit. Ent.* I. pp. 124. and 128.

Fam. A. *Sphinges caudacutæ—Larvæ ophthalmicæ.*

Species.	Icon.
1. D. *Nerii*, Linn.	Ernst, III. Pl. CIV. f. 153. a—f.
2. — *Celerio*, Linn.* ...	Ernst, III. Pl. CX. f. 157. a—e.
3. — *Elpenor*, Linn.*...	Ernst, III. Pl. CXII. f. 160. a—g.
4. — *Porcellus*, Linn.* .	Ernst, III. Pl. CXIII. f. 161. a—i.

Fam. B. *Sphinges semifasciatæ—Larvæ maculatæ.*

5. D. *Lineata*, Fab.† ..	Ernst, III. Pl. CX. f. 158. a—c. Pl. CXI. f. 158. d. e.—Steph. Pl. XII. f. 1.
6. — *Galii*, Hübn.† ...	Ernst, III. Pl. CIX. f. 156. a—f. Steph. Pl. XII. f. 2.
7. — *Hippophaes*, Esp.	Hübn. Sphing. Tab. 22. f. 109. (fœm.)
8. — *Nicæa*, De Prunner.....	Hübn. Sphing. Tab. 24. f. 115. (fœm.)
9. — *Euphorbiæ*, Linn.†	Ernst, III. Pl. CVII. f. 155. a—f. Curtis, I. Pl. III.
10. — *Zygophylli*, Hoffm.	Hübn. Sphing. Tab. 27. f. 125. (mas.)
11. — *Vespertilio*, Fab..	Ernst, III. Pl. CXI. f. 159. a—d.

* Sect. B.—*Steph. l. c.*

† Sect. A.—*Steph. l. c.*

Genus 26. SPHINX, *Fab.*, *Latr.*, *Steph.*

Spectrum, Scop. Eumorphæ, Hübn.

Wings lanceolate, entire.

Antennæ rather elongate, gradually, but slightly increasing in thickness from the base nearly to the apex, especially in the females; the apex attenuated, uncinated, and terminated by a scaly seta. (Steph.)

Palpi contiguous at their apex, densely clothed with hair. (Steph.)

Maxillæ very long, (Steph.) and strong.

Head large, subtrigonate; (Steph.) eyes very large.

Body thickly covered with hair; (Steph.) abdomen generally marked posteriorly with transverse light and dark coloured bands.

Larva smooth, not hairy, *head* flat, obtuse, oval; *caudal horn* on the penultimate segment large, smooth and incurved; *body* marked with oblique lateral stripes.

Pupa smooth, the sheath of the maxillæ always prominent; metamorphosis subterranean.

Species.	Icon.
1. Sp. *Pinastri*, Linn....	Ernst, III. Pl. LXXXVIII. f. 115. a—f.
2. — *Convolvuli*, Linn..	Ernst, III. Pl. LXXXVI. f. 114. a—e. Pl. LXXXVII. f. 114. f—k.
3. — *Ligustri*, Linn. ...	Ernst, III. Pl. LXXXV. f. 113. a—g.

Genus 27. ACHERONTIA, *Ochs.*, *Steph.*

Manducæ, Hübn. Sphinx, Linn. Fab. Latr.
Spectrum, Scop.

Legs, tarsi terminated by sharp claws, tibiæ spinous.

Wings broad, entire; the posterior slightly emarginated: *cilia* very short.

Antennæ short, very gradually and slightly thickening from the base nearly to the apex, uncinated, the hook terminating in a long, hairy seta. (Steph.)

Palpi not contiguous, applied close to the head, naked inwardly, densely clothed with hair outwardly. (Steph.)

Maxillæ very short, robust.

Head large.

Body obtuse, densely clothed with short velvety pile. (Steph.)

Larva smooth, not hairy, with oblique, purplish-coloured lateral stripes; anal horn tuberculated, deflexed, and curved at the apex.

Pupa

Pupa smooth, *metamorphosis* subterranean.

Species.	Icon.
1. Ach. *Atropos*, Linn. .	Ernst, III. Pl. CV. f. 154. a—f. Pl. CVI. f. 154. g—k. Pl. CXXII. f. 154. n. (Thorax of a female, without the mark of the Death's-Head.)—Curtis, Brit. Ent. IV. Pl. CXLVII. (Imago et Larva, figuræ pulcherrimæ.)

Genus 28. SMERINTHUS, *Latr.*, *Steph.*

Laothöe, Fab. Spectrum, Scop.
Amorpha, Hübn.

Wings, anterior more or less dentated, or angulated.
Antennæ incrassated towards the middle, sub-prismatic, serrated or pectinated; apex generally incurved, and pointed.
Palpi contiguous, very thickly covered with scales, third joint scarcely distinct.
Head small; *maxillæ* very short, or obsolete.
Larva very much granulated, head conical, last segment with a conical, recurved horn. (Steph.)
Pupa slightly rugose, acute, pointed at the apex; *metamorphosis* subterranean. (Steph.)

Species.	Icon.
1. Sm. *Tiliæ*, Linn.....	Ernst, III. Pl. CXVI. f. 163. a—e.
2. — *Ocellata*, Linn. ...	Ernst, III. Pl. CXIX. f. 164. a—g.
— *Ocellatus*, Steph...	
3. — *Populi*, Linn.	Ernst, III. Pl. CXIV. f. 162. a—f.
4. — *Quercus*, Fab.....	Ernst, III. Pl. CXX. f. 165. a—f.

NOCTURNAL LEPIDOPTERA.

Genus 29. SATURNIA, *Schrank.*, *Steph.*

Bombyx., Fab., Latr. Herææ, Hübn.
Phal. Attacus, Linn. Esp.

Wings rounded, entire, broad, exterior margin incurved, horizontally expanded when at rest; posterior ones simple: *cilia* very short.
Antennæ subcylindric, very short, in the male bi-pectinate, (the pectinations divergent and diminishing in length to the apex of the antennæ, each joint of which bears two ramifications, internally and externally; female with each joint bidentate. (Steph.)
Palpi and *maxillæ* obsolete, their place occupied by a dense tuft of hair. (Steph.)
Head small, scarcely visible from above. (Steph.)

Thorax

Thoraæ stout, densely pilose.
Abdomen abbreviated in the males; rather elongate and stout in the females, pilose, slightly tufted at the apex. (Steph.)
Larva naked, with a coloured ring on each segment, adorned with several whirls of hair, placed upon distinct warts. (Steph.)
Pupa inclosed in a rigid pyriform folliculus. (Steph.)

Species.	Icon.
1. Sa. *Pyri*, Hübn.	Ernst, IV. Pl. CXXX. f. 176. a—f. Pl. CXXXI. f. 176. g—i.
2. — *Spini*, Hübn.....	Ernst, IV. Pl. CXXXII. f. 177. a—h.
3. — *Carpini*, Hübn...	Ernst, IV. Pl. CXXXIII. f. 178. a—h.

Genus 30. AGLIA, *Ochs.*

Echidnæ, Hübn. Ph. Attacus, Linn. Esp.
Saturnia, Schrank.

Wings entire, broad, horizontally expanded; posterior simple: *cilia* moderate.
Antennæ short; of the male bipectinated, each joint bearing a single pectination, the latter diminishing in length towards the apex of the antennæ; female with each joint unidentate, not pectinated.
Palpi distinct, rather short, clothed with scales, compressed, triarticulate, terminal joint short, ovate.
Maxillæ obsolete.
Head moderate.
Thoraæ rather short.
Abdomen moderate, pilose, tufted at the apex.
Larva naked, fleshy, the back subnodose.
Pupa slightly hairy, folliculated *.

Species.	Icon.
1. Agl. *Tau*, Linn.....	Ernst, IV. Pl. CXXIX. f. 175. a—i.

Genus 31. ENDROMIS, *Ochs.*, *Steph.*

Dimorphæ, Hübn. Bombyx, Latr. Schr. &c.
(Dorvillia, Leach †.)

Legs slender; *hinder tibiæ* with a minute pair of spurs at the apex only.

* The Generic characters are taken from Stephens.—*Illust. Brit. Ent., Haustellata*, II. p. 36.
† Edinburgh Encyclopædia, Art. "Entomology."

Wings broad, subtriangular, entire, somewhat diaphanous, pilose, without a dorsal prominence: *cilia* extremely short.

Antennæ filiform, closely bipectinated in both sexes, the bipectinations shortest in the female, and in both sexes incurved and terminating rather abruptly at the apex.

Palpi very short, hairy, compressed, recurved, obtuse.

Maxillæ obsolete.

Head, *thorax* and *abdomen* thickly clothed with very fine long hairs, which also envelope the base of the wings.

Larva naked, attenuated in front with a pyramidal elevation at the anal segment, and oblique lateral stripes.

Pupa folliculated, not subterranean *.

Species.	Icon.
1. En. *Versicolora*, Linn.	Ernst, IV. Pl. CXXV. f. 169. a—g. Pl. CXXVI. f. 169. h—l.

Genus 32. HARPYIA, *Ochs.*

Cerura, Schr. Steph. Andriæ, Hübn.

Legs woolly; *anterior tibiæ* with an elongate, compressed lobe; *posterior* simple.

Wings entire, somewhat diaphanous, deflexed, *anterior* elongate.

Antennæ bipectinate in both sexes, in some species with the apex simple; the pectinations longest in the males, and ciliated.

Palpi four; *labial* small, tri-articulate, compressed, apex obtuse; *maxillary* minute, attenuated at the tip.

Maxillæ very short, flat, not spiral.

Head moderate.

Thorax rather stout, not crested.

Abdomen moderate, robust in the females, with the apex obtuse, slightly tufted in the males; beneath woolly.

Larva robust, anteriorly truncate, with an elevation on the third segment; the anal feet produced into two long retractile filaments, with two short spines between.

Pupa inclosed in a hard case, generally formed of agglutinated pieces of woody fibre †.

A. *Antennæ bipectinate throughout.*

Species.	Icon.
1. H. *Vinula*, Linn.....	Ernst, V. Pl. CCIV. f. 271. a—i.

* Characters from Stephens, who places this genus in his second family of *Lepidoptera nocturna, notodontidæ.*—*Illust. Brit. Ent., Haustell.* II. p. 33.

† Characters chiefly from Stephens.—*Illust. Brit. Ent., Haustell.* II. p. 15.

2. H. *Ermi-*

Species.	Icon.
2. H. *Erminea*, Esp.	Ernst, V. Pl. CCV. f. 272. a—g.
3. — *Bicuspis*, Hübn....	Ernst, V. Pl. CCVI. f. 273. i. Steph. Haustell. II. Pl. 13. f. 3.
4. — *Bifida*, Hübn. ...	Ernst, V. Pl. CCVI. f. 273. f—h. (mas.) k. l. (fœm. Var.)—Steph. Illust. Brit. Ent. Pl. 15. f. 2.
5. — *Furcula*, Linn. ...	Ernst, V. Pl. CCVI. f. 273. b. (larva). d. (mas.) e. f. (fœm.)*

B. *Antennæ with the apex bare.*

6. H. *Ulmi*, Borkh.....	Ernst, V. Pl. CXCIV. f. 256. a—c.
7. — *Fagi*, Linn. †.....	Ernst, V. Pl. CCIII. f. 270. a—g.
8. — *Milhauseri*, Fab..	Ernst, V. Pl. CCII. f. 269. a—g.

Genus 33. NOTODONTA, *Ochs.*

Ptilodontes, Hübn.

(Notodonta, Leiocampa, Lophopteryx, Ptilodontis, Ptilophora, Chaonia, Peridea, Steph.)

Wings, anterior generally with a tuft of hairs on the interior

* The following species, belonging to the first section, not noticed by Ochsenheimer, are given by Stephens.

1. *Cerura integra*, Steph.....	Steph. Illust. Brit. Ent. Pl. XV. f. 3.
2. ——— *arcuata*, Steph.[a]	
3. ——— *latifascia*, Curtis	Curtis, Brit. Ent. IV. Pl. CXCIII.
4. ——— *fuscinula*, Steph. Hübn.?	Steph. Illust. Brit. Ent. Pl. XV. f. 1.

† Stauropus fagi, *Steph.*

Mr. Stephens has separated this insect from the *Ceruræ*, and placed it by itself under Germar's genus *Stauropus*, which "differs from the other genera of this family by having several patches of elevated scales on the anterior wings, which are rather densely clothed with scales, and somewhat pilose."

"Genus 38. STAUROPUS, *Germar.*

"*Palpi* short, clothed with elongate scales, straight, cylindric, biarticulate, the terminal joint acute; *maxillæ* obsolete. *Antennæ* porrect, simple at the apex; of the male, strongly bipectinated from the base nearly to the tip; of the female, simple throughout; *head* very small; *eyes* large; *thorax* not very stout, nor crested; *abdomen* somewhat elongate, rather attenuated towards the apex, which is furnished in both sexes with a tuft of fine woolly hair; *wings* entire, thickly clothed with scales, with several elevated tufts of scales and down; *anterior* lanceolate-ovate; *posterior* ovate-triangular; *legs* rather short, thickly clothed with down: *anterior tibiæ* in both sexes with an elongate attenuated spine or lobe; *posterior* with spines at the apex only. *Larva* naked, the back with several acute protuberances, the caudal segments laterally expanded and reflexed, with the hinder prolegs converted into two styliform processes: *pupa* folliculated."—Steph. *Illust. Brit. Ent. Haust.* II. 21.

[a] "*C. arcuata.* Alis griseis, anticis basi, margineque postico nigro punctatis, fasciâ transversâ angustâ cinereâ nigro marginatâ, strigâque posticâ flexuosâ arcuorum (arcuum?) nigrorum, thorace antice cinereo."—*Steph. l. c.*

margin, which when at rest are elevated, and form a tooth-like projection on the back.

Antennæ bipectinate in the males; in the females occasionally filiform and simple.

Antlia very short.

Larva naked, with protuberances on the middle segment; or with two points or tubercular projections on the anal segment; or quite smooth.

Pupa with the apex aculeated.*

Fam. A.—*Larvæ* with protuberances on the middle segment; head and anal segments elevated when at rest.

	Species.	Icon.
1.	N. *Tritophus*, Fab....	Ernst, V. Pl. CCII. f. 268. a—e.
2.	— *Ziczac*, Linn.†	Ernst, V. Pl. CC. f. 266. a—c. Pl. CCI. f. 266. d—g.
3.	— *Torva*, Hübn.	Ernst, IV. Pl. CXXVII. f. 172. a—c.
4.	— *Dromedarius*, Linn.†	Ernst, V. Pl. CCI. f. 267. a—f.

* These insufficient characters are given literally from Ochsenheimer. Mr. Stephens, as seen in the synonyma above, has divided this group into no less than seven genera, the characters of which I shall annex as the species occur on which they are respectively formed, in order that such entomologists as do not possess Mr. Stephens's elegant and important "Illustrations" may, if they please, be enabled to adopt his views, and know on what grounds they are established.

† Notodonta, Steph.

"N. *Palpi* short, very hairy, biarticulate, basal joint minute, terminal compressed, truncate; *maxillæ* short. *Antennæ* filiform, bipectinated in the males, the pectinations short, and nearly vanishing at the apex; in the females, slightly denticulated interiorly, and ciliated: *head* and *eyes* small; *thorax* not crested; *abdomen* somewhat elongated, robust, subcylindric; the apex downy: *wings*, *anterior* obtuse at the apex, with the hinder margin rounded and denticulated; the interior, or dorsal edge, with a projecting tuft of scales in the centre: *legs* short, robust, densely clothed with scales and hair; the *anterior tibiæ* anteriorly with an elongate lobate appendage; *anterior tarsi* short, stout, clothed with elongate scaly hair. *Larva* naked, with two or more conical protuberances on the back, the anal segment reflected, and bearing two imperfect prolegs: *pupa* subterranean, folliculated."—Steph. *Illust. Brit. Ent. Haust.* II. 22.

Stephens's second species, *No. perfusca* (*B. perfuscus?* Haw.), is not noticed by Ochsenheimer.

"Sp. 2. *perfusca*—Pl. XIV. f. 2. Alis anticis fusco-nebulosis, liturâ baseos anique flavescentibus, strigis duabus denticulatis obsoletis."—*Steph. l.c.* p. 23.

Stephens is not positive that this insect is distinct from *No. Dromedarius*, but is inclined to think it is. It is found near Dublin.

5. N. *Tri-*

Species.	Icon.
5. N. *Cucullina*, Hübn.*	Hübn. Bomb. Tab. 5. f. 20. (fœm.)

Fam. B.—*Larvæ* with two conical projections on the anal segment; the head and anterior segments elevated and thrown back when at rest.

6. N. *Camelina*, Linn.*.	Ernst, V. Pl. CXCIX. f. 263. a—i.
7. — *Carmelita*, Esp.*.	Hübn. Bomb. Tab. 5. f. 21. (mas.)

Fam. C.—*Larvæ* tuberculated, especially on the anal segment.

8. N. *Dictæa*, Linn.†...	Ernst, V. Pl. CXCVII. f. 260. a. (larva) b. (pupa) f. 261. d—f.
9. — *Dictæoides*, Esp.†	Ernst, V. Pl. CXCVII. f. 261. a. b. (larva) c. (pupa) f. 260. c—e.
10. — *Argentina*, Fab...	Ernst, V. Pl. CXCVIII. f. 262. a—i.

Fam. D.—*Larvæ* quite smooth.

11. N. *Palpina*, Linn.‡..	Ernst, V. Pl. CXCVI. f. 259. a—h.

12. N. *Plu-*

* Lophopteryx, Steph.

"L.—*Palpi* short, hairy, slightly ascending, biarticulate, the first joint elongate, curved at the base, the terminal one short, ovate; *maxillæ* short, a little spiral. *Antennæ* short, filiform, simple and ciliated in the females, very slightly bipectinated in the males," (bipectinations) "nearly vanishing towards the apex: *head* small; *eyes* moderate: *thorax* crested: *abdomen* not elongate, rather stout; apex of the male with a trifid scaly tuft: *wings* compressed when at rest; *anterior* subtriangular, the hinder margin rounded, and rather deeply denticulated; the interior with a single, elongate, squamous tooth towards the centre: *legs* rather slender, downy; the apex of the *tibiæ* with two elongate spurs; the *anterior* internally simple. *Larva* slightly hairy, with one or two conical protuberances on the anal segment alone; hinder prolegs perfect: *pupa* folliculated."—*Steph. l. c.* II. 26.

† Leiocampa, Steph.

"L.—*Palpi* extremely minute, enveloped in dense hair: *maxillæ* obsolete. *Antennæ* filiform, bipectinated in both sexes to the apex; the pectinations shorter, but not vanishing at the tip, and abbreviated in the female: *head* hairy in front: *eyes* moderate; *thorax* not crested: *abdomen* elongate, cylindric, tufted at the apex: *anterior wings* elongate, rather acute at the apex, the posterior margin slightly rounded and obsoletely denticulated; the interior with a single squamous tooth towards the centre: *legs* short, not very stout; *femora* and *tibiæ* densely clothed with hair; *tarsi* slender: *anterior tibiæ* with a very short spine-like process interiorly. *Larva* naked, with a small conical protuberance on the anal segment only: caudal legs perfect: *pupa* subterranean, folliculated."—*Steph. l. c.* II. 24.

‡ Ptilodontis, Hübn. Steph.

"P.—*Palpi* considerably elongated, porrect, ascending, clothed with elongate scales: *maxillæ* short. *Antennæ* filiform, bipectinated in both sexes, the pectinations shortest in the females: *head* minute: *eyes* small;

	Species.	Icon.
12.	N. *Plumigera*, Fab.*	Ernst, V. Pl. CXCV. f. 257. a—d.
13.	— *Bicolora*, Fab. ...	Ernst, IV. Pl. CXXVI. f. 170. b—e.
14.	— *Velitaris*, Hübn...	Ernst, V. Pl. CC. f. 264. a. b.
15.	— *Melagona*, Hübn.	Ernst, V. Pl. CC. f. 265. a—c.
16.	— *Crenata*, Esp.	Ernst, V. Pl. CLXXXIII. f. 237. a—c.
17.	— *Dodonæa*, Hübn.†	Ernst, V. Pl. CLXXXVII. f. 243. a—e.
18.	— *Chaonia*, Hübn.† (*Roboris*, Steph.)	Ernst, IV. Pl. CXXVIII. f. 174. a—f.
19.	— *Querna*, Fab.†. ...	Ernst, IV. Pl. CXXVIII. f. 173. a—d.
20.	— *Trepida*, Fab.‡...	Ernst, IV. Pl. CXXVII. f. 171. a—e.

Genus 34.

small: *thorax* slightly crested: *abdomen* elongated, tufted at the apex, the tuft bifid in the male: *anterior wings* denticulated at the hinder margin, the interior edge with two recurved tufts of elongate scales, the basal one the largest; *posterior* entire: *legs* moderate, downy; *tibiæ* with spurs at the apex. *Larva* naked, smooth, without any dorsal prominences, head very acute: *pupa* subterranean, folliculated."—*Steph. l. c.* II. 28.

* Ptilophora, Steph.

"P.—*Palpi* minute, enveloped in dense elongated hairs; *maxillæ* very short. *Antennæ* slender, of the males furnished with extremely long plumose radii, of the females subserrated; *head* densely pilose, small: *eyes* moderate: *thorax* not crested, pilose: *abdomen* scarcely elongated, clothed with velvety pile, and slightly tufted in the male: *wings* subdiaphanous, pilose; *anterior* with the apex entire, the inner margin obsoletely denticulated; *posterior* entire; *legs* short, robust, downy: *tibiæ* with minute spurs at the apex. *Larva* without dorsal protuberances: *pupa* subterranean, folliculated."—*Steph. l. c.* II. 29.

† Chaonia, Steph.

"Ch.—*Palpi* very minute, slightly porrect, recurved at the base, pilose: *maxillæ* extremely short. *Antennæ* bipectinated in the males to the apex, in the females subserrated and ciliated: *head* small, pilose, with a distinct fascicle of hairs at the base of each antenna: *eyes* moderate: *thorax* slightly crested: *abdomen* not elongated, clothed with short down: *wings* opaque, squamous: *anterior* entire at the apex, with an obsolete denticulation on the inner edge; *posterior* entire: *legs* short, downy: *tibiæ* with spurs at the apex, *anterior* with a compressed spine. *Larva* naked, without dorsal protuberances; anal legs perfect: *pupa* subterranean, folliculated."—*Steph. l. c.* II. 30.

‡ Peridea, Steph.

"Pe.—*Palpi* very short, hairy, triarticulate, the basal and terminal joints minute: *maxillæ* short. *Antennæ* elongate, serrated, bipectinated nearly to the apex in the males: *head* small, pilose: *thorax* slightly crested, robust, hairy: *abdomen* scarcely elongated, rather stout, slightly tufted at the apex: *thorax* and *body* beneath very downy: *legs* short, stout, densely clothed with hair and down to the middle of the tarsi; *anterior tibiæ*

Genus 34. COSSUS, *Fab.*, *Latr.*

HEPIALUS, Schr. TEREDINES, Hübn.

Legs, tibiæ with spurs. (Steph.)

Wings entire, strong; interior margin of the *anterior* repand.

Antennæ setaceous, as long as the thorax, furnished with a single row of short, transverse, obtuse teeth, (Latr.) on their inner edge. (Steph.)

Palpi very distinct, cylindrical, rather thick, squamose, (Latr.) three-jointed. (Steph.)

Head small, with a pilose crown; *thorax* stout, scaly; *abdomen* robust, elongate, (Steph.) that of the female terminated by a prominent aculeus.

Larva smooth, with a few fine, short hairs; living in the trunks of trees, lignivorous.

Pupa posteriorly spinous, inclosed in a case formed of the particles of rotten wood cemented by gluten.

A.—Antennæ pectinated.

Species.	Icon.
1. C. *Ligniperda*, Fab.	Ernst, V. Pl. CLXXXIX. f. 246. a—g. Pl. CXC. f. 246. h—k. Curt. Brit. Ent. Pl. 60. (Imago et larva, figuræ perpulchræ.)
2. — *Terebra*, Fab.	Ernst, V. Pl. CXX. f. 246. l.
3. — *Cæstrum*, Hübn...	Hübn. Bomb. Tab. 46. f. 199. (mas.)
4. — *Pantherinus*, Ochs.	Ernst, V. Pl. CXCIII. f. 254. a. b.

B.—Antennæ in the male semi-pectinated; apex slightly crenate.

5. C. *Arundinis*, Hübn.	Hübn. Bomb. Tab. 47. f. 200. (mas.) 201. (fœm.)
6. — *Æsculi*, Linn.*	Ernst, V. Pl. CXC. f. 247. a—d.

tibiæ with a spiniform lobe on the inner margin: *wings* entire, subdiaphanous; *anterior* lanceolate-ovate, with a single prominence on the inner margin. *Larva* naked, without dorsal protuberances, the back slightly rugose, the sides obliquely streaked: *pupa* folliculated, the folliculus placed on the surface of the ground."—*Steph. l. c.* II. 32.

* ZEUZERA, Latr. Steph.

"*Antennæ* not so long as the thorax, setaceous, of the males pectinated at the base, with the apex simple; of the females entirely simple, with the base tomentose; *palpi* obsolete; *wings* entire, elongate, lanceolate, unequal. *Head* small, tomentose: *thorax* stout, thickly clothed with hair: *abdomen* not very robust, much elongated, attenuated, clothed with short hair: *legs* rather long, shanks unarmed. *Larva* residing in the trunks of trees, lignivorous; *pupa* inclosed in a case of wood, cemented by a glutinous substance."—*Steph. Illust. Brit. Ent.* II. p. 8.

Stephens adds, that *Zeuzera* is distinguished from *Cossus* by its antennæ in both sexes having the apical half simple, by the form and texture of the wings, and by the slenderness of its tomentose body.

Genus 35. HEPIOLUS, *Illig.*, *Hübn.*

HEPIALUS, Fab. Latr. Schrank. (Steph.)

Legs, tibiæ unarmed.
Wings oblong-lanceolate, sub-equal.
Antennæ much shorter than the thorax, subfiliform, or moniliform, sometimes pectinated or serrated.
Palpi obsolete.
Head small; *thoraæ* woolly; *abdomen* rather stout, elongate, the apex tufted in the males.
Larva subterranean, radicivorous.
Pupa elongate, rather stout, obtuse, with two parallel rows of spinous processes: changes in a web amongst the food of the larva.*

Species.	Icon.
1. H. *Humuli*, Linn.† ...	Ernst, V. Pl. CXCI. f. 248. a—k.
2. — *Velleda*, Hubn.† .	Hübn. Bomb. Tab. 50. f. 212. (mas.) Tab. 54. f. 233. (mas.) 234. (fœm.)
3. — *Carnus*, Fab.†	Ernst, V. Pl. CXCIII. f. 251. d. e.
4. — *Sylvinus*, Och.‡ ...	Ernst, V. Pl. CXCII. f. 249. a—g. Curtis, Brit. Ent. IV. Pl. 185. f. sup. ♂ f. inf. ♀.
5. — *Ganna*, Hübn. ...	Hübn. Bomb. Tab. 50. f. 215. (mas.)
6. — *Lupulinus*, Fab.† .	Ernst, V. Pl. CXCIII. f. 252. a—d.
7. — *Hectus*, Fab.†.....	Ernst, V. Pl. CXCIII. f. 251. a—c.

Genus 36. PHYCIS, *Fab.*, *Latr.*

EUPLOCAMUS, Latr.

Legs, posterior with the tibiæ armed with spines.
Wings small; posterior margin rounded.
Antennæ very strongly pectinated.
Palpi with the second joint hairy, with very numerous elongated scales, produced into a fasciculus; the third nearly naked, ascending. (Latr.)
Larva naked, except a few scattered hairs on the body; inhabits rotten wood.
Pupa elongated; the hinder part armed with fine hamuli; changes in a delicate closed web, formed in the cavities inhabited by the larva.

* Generic characters from Stephens (*Illust. Brit. Ent. Haust.* II. p. 4.), who divides the genus into two sections; the first (A) having the antennæ simple in both sexes, the second (B) having them pectinated or serrated.
† Steph. Sect. A. ‡ Steph. Sect. B.

1. P. *Bo-*

Species.	Icon.
1. P. *Boleti*, Fab.	Hübn. Tineæ, Tab. 3. f. 18. (fœm.)
2. — *Mediella*, Hübn..	Hübn. Tin. Tab. 3. f. 19. (fœm.)
3. — *Anthracina*, Ochs.	Hübn. Pyralides, Tab. 4. f. 22. (mas.)

Genus 37. LITHOSIA, *Fab.*, *Latr.*

Setina, Schreb. Callimorpha, Latr.*
Hippocritæ, Hübn.

Legs, anterior with the coxæ long and robust; *thighs* very long and slender; *tibiæ* short and slender; *tarsi* 5-jointed; *pulvilli* distinct; *claws* obscure.

* Ochsenheimer has divided this genus into four families, the first of which agrees pretty nearly with the second division of Latreille's genus *Lithosia*, and the second family contains three species of his genus *Callimorpha*. Several species of the genera *Lithosia* and *Callimorpha*, Latr. are arranged by Ochsenheimer under his own genus *Eyprepia*. Altogether, no small share of confusion prevails with respect to the species of these three genera; and we hope that some one better qualified for the task than ourselves, and not too fond of creating new genera, will disentangle this perplexed web. We are already indebted to Mr. Curtis for having done something towards it; and the sure grounds which that author goes upon—dissection of the essential parts, and the admirable manner in which those dissections are executed and delineated—not only create unlimited confidence in his results, but leave nothing to wish for, as far as he has gone. To him and to Mr. Stephens, amongst our own entomologists, now actively and so much to their own honour devoted to the science, we must look to have "all these odds made even." Of his genus *Lithosia*, Latreille says (*Nouv. Dict. d'Hist. Nat.* vol. xviii. p. 130. 1817.), "This genus answers in great measure to the genus *Lithosia* of Fabricius, and to the *Setines* (*Setina*) of Schrank." And a little further, "M. Ochsenheimer, in his Lepidoptera of Europe, arranges some of my *Lithosiæ* with his *Eyprepiæ*, which comprehend many species of *Arctia*, and my *Callimorphæ*." "The *Lithosiæ*," Latreille adds, "are, in general, species of *Bombyx*, having the form of *Tineæ*, either narrow or elongated, adorned with pleasing colours, sometimes uniform, sometimes variegated, and marked with dots, maculæ, or bands. Their wings form a sort of mantle. These Lepidoptera remain quiet, during the day, on the trunks of trees, or the stems of plants."

The species enumerated by Curtis (*Brit. Ent.* I. 36.) as belonging to this genus are eight: namely, *L. muscerda*, Hübn.; *flava*, Fab.; *aurantia*, Haw.; *ochreola*, Hübn.; *helveola*, Hübn.; *complana*, Linn.; *griseola*, Hübn.; and *quadra*, Linn.: and he concludes the subject with the following observation: "*L. quadra* will form a second division in this genus, since the second joint of the palpus is as long as the first, and curved upward; *Bombyx pulchella* and *rubricollis*, Fab., with some others, are included by that author and Latreille in the genus *Lithosia*, which has occasioned the latter to state that the palpi are three-jointed, whereas Fabricius has described them as biarticulate: after dissecting several specimens of our genus, and examining them most carefully, I can discover only two joints; *B. pulchella* and *rubricollis* having three distinct joints in the palpi, must therefore be constituted into a new genus."

Wings long, oblong, somewhat elliptic, incumbent or convolute; *inferior* ones much folded.

Antennæ remote, covered with long scales above, hairy beneath, pectinated (under a lens), the pectinations arising from the centre of the joints on each side.

Palpi two, generally shorter than the head, covered with various scales; the apex nearly naked, 2-jointed, first joint long, cylindric, attenuated, curved upwards; second joint small, somewhat rhomboid.

Head short, covered with close scales (not hairy in front); *eyes* remote *.

Fam. A.—Antennæ filiform, setaceous; setæ very delicate, and inserted in the joints; posterior legs long, armed with spines: anterior wings small, long, convolute; posterior broad and plicate. (Ochs.)

Larva hairy, subfusiform, variegated; live chiefly in moss on trees.

Metamorphosis occurs in a fine web.

Species.	Icon.
1. L. *Quadra*, Linn. ...	Ernst, VI. Pl. CCXVII. f. 298. a—k.
2. — *Griseola*, Hübn. .	Ernst, VI. Pl. CCXIX. f. 303. a—d.
3. — *Complana*, Linn. .	Ernst, VI. Pl. CCXVIII. f. 301. a—c.
4. — *Caniola*, Hübn....	Hübn. Bomb. Tab. 81. f. 220. (mas.)
5. — *Depressa*, Esp. ...	Hübn. Bomb. Tab. 23. f. 96. (fœm.)
6. — *Helveola*, Ochs....	Ernst, VI. Pl. CCXVIII. f. 302. a—c.
7. — *Unita*, Hübn.	Hübn. Bomb. Tab. 51. f. 221. (mas.) Tab. 23. f. 93. (fœm.)
8. — *Gilveola*, Ochs....	Hübn. Bomb. Tab. 23. f. 91. (fœm.)
9. — *Luteola*, Hübn....	Ernst, VI. Pl. CCXVIII. f. 300. a—c.
10. — *Aureola*, Hübn....	Ernst, VI. Pl. CCXVIII. f. 299. a—c.
11. — *Rubricollis*, Linn.	Ernst, VI. Pl. CCXXII. f. 311. a—c.
12. — *Muscerda*, Hübn.	Hübn. Bomb. Tab. 24. f. 103. (fœm.) Curtis, Brit. Ent. I. Pl. 36.

Fam. B.—Anterior wings broad, deflexed.

13. L. *Rosea*, Fab.	Ernst, VI. Pl. CCXXI. f. 310. a—f.

* Generic characters from Curtis, l. c.

14. L. *Ros-*

Species.	Icon.
14. L. *Roscida*, Fab. ...	Ernst, VI. Pl. CCXX. f. 307. a—d.
15. — *Irrorea*, Hübn....	Ernst, VI. Pl. CCXX. f. 306. a—e.
16. — *Aurita*, Esp.	Ernst, VI. Pl. CCXIX. f. 305. a—c.
17. — *Ramosa*, Fab.	Ernst, VI. Pl. CCXIX. f. 305. d.
18. — *Eborina*, Hübn...	Ernst, VI. Pl. CCXIX. f. 304. a—c.
19. — *Jacobeæ*, Linn. ...	Ernst. VI. Pl. CCXXII. f. 312. a—f.

Fam. C.—Antennæ setaceous; anterior wings broad, with semi-transparent spots; posterior wings very small: posterior portion of the body with black dots.

20. L. *Ancilla*, Linn. ...	Ernst, VI. Pl. CCXXIII. f. 314. a—e.
21. — *Punctata*, Fab. ...	Ernst, VI. Pl. CCXXIII. f. 315. a. b.

Fam. D.—Antennæ setaceous; in the male the setæ extremely delicate, and scarcely visible to the naked eye; wings broad, rounded, sub-diaphanous, with dark-coloured spots.

22. L. *Mundana*, Linn. .	Hübn. Bomb. Tab. 17. f. 63. (mas.) 64. (fœm.) f. 65. (mas.)
23. — *Murina*, Hübn....	Hübn. Beitr. II. B. 3. Th. II. Taf. fig. K. S. 66.—Bomb. Tab. 17. f. 62. (mas.)
24. — *Senex*, Hübn.	Hübn. Bomb. Tab. 55. f. 236. (mas.) 237. (fœm.)

[To be continued.]

VI. *On the superior Qualities of the Ash Timber which grows at Earls Barton, in Northamptonshire.* *By* B. Bevan, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HAVING been informed that the *Ash timber* which grows in the parish of Earls Barton, in the county of Northampton, and in the adjoining parishes, is supposed to possess superior qualities to any ash timber growing in different parts of the country, I obtained a specimen of it for the purpose of ascertaining, by a set of experiments, how far this opinion of its superior qualities was correct. The results of my experiments I beg leave to offer to the public through the medium of your Magazine, with a view to excite a comparison with the qualities of ash timber growing in different parts of the country. The specimen I obtained, appeared to have been taken from near the butt or lower part of a young tree. Its specific gravity was ·765. I found the modulus of elasticity to be

957,000 pounds. Upon examining the experiments of Mr. Barlow and of Mr. Tredgold on ash timber, it will be found that the modulus of elasticity of the specimens tried by them was 1,645,187 and 1,525,500 pounds respectively; so that the *flexibility* of Earls-Barton ash, when compared with the wood tried by Mr. Barlow and Mr. Tredgold, is nearly as 5 to 3. The cohesion of Earls-Barton ash, as deduced from its transverse strength, I found to be little more than 10,000 pounds per square inch: but upon trying the cohesion by the direct longitudinal force to pull it asunder, I obtained 24,700 pounds.

Mr. Barlow gives the cohesion of ash 17,337 pounds, and Mr. Tredgold 14,130 pounds; the mean of these being 15,733 pounds: from which it appears that Earls-Barton ash is superior to those just referred to in the ratio of 11 to 7.

The *ultimate deflection* before fracture took place, according to the formula of Mr. Barlow, I found to be about $2\frac{1}{2}$ times greater than the ultimate deflection of ash in Mr. Barlow's tables.

Now if we estimate the *toughness* of wood to be in the compound proportion of its cohesive strength and its ultimate deflection, we shall have $\frac{24,700}{2} : \frac{17,337}{5} :: 12,350 : 3465$; or in small numbers, 7 : 2 nearly; which shows that where *toughness* is an essential quality, the ash growing in the neighbourhood of Earls Barton excells other wood of the same species, and tried by Mr. Barlow, in the scale of $3\frac{1}{2}$ to 1.

I am, Gentlemen, yours truly,

Leighton Buzzard, Dec. 12, 1828. B. Bevan.

VII. *On the Longitudes of the Trigonometrical Survey of England. By Dr.* J. L. Tiarks, *F.R.S. &c.**

MR. IVORY has proved (Phil. Mag. and Annals, July, page 10) that, according to our present knowledge of the figure of the earth, the difference of longitude between Beachy Head and Dunnose ought to be $18''$ more than the result reduced in the Trigonometrical Survey; and he has subsequently (Phil. Mag. and Annals, October, page 244) endeavoured to account for a part of this difference, by proving an error in the formula by which that difference of longitude was calculated from the data furnished by the Survey. The formula is this (retaining Mr. Ivory's symbols):

$$\text{Tang } \tfrac{1}{2}\omega = \frac{\cos\left(\frac{\lambda-\lambda'}{2}\right)}{\sin\left(\frac{\lambda+\lambda'}{2}\right)} \text{ cotang } \frac{m+m'}{2}$$

* Communicated by the Author.

Now Mr. Ivory contends that the quantity on the right-hand ought to be multiplied by $\left(1+\frac{e^2}{2}\cos\left(\frac{\lambda+\lambda'}{2}\right)^2\right)$; thus adding to the former value of tang $\frac{1}{2}\omega$ a quantity multiplied by the square of the excentricity, which increases the value of ω deduced from the formula by a quantity nearly equal to $\frac{e^2}{2}\cos\left(\frac{\lambda+\lambda'}{2}\right)^2 \sin\omega$. In the case in question this quantity amounts to $7''$, and would thus leave only $11''$ of the difference in longitude to be accounted for by the errors in the data of the Survey, principally by the errors in the sum of the azimuths. I have endeavoured to prove that in the development of the value of tang $\frac{1}{2}\omega$ there is no such term, involving the square of the excentrictiy, and Mr. Ivory's last paper has not proved the contrary. At the same time I have fallen into the mistake of contending that the formula for tang $\frac{1}{2}\omega$ is rigorously correct; while it really contains terms proportional to the fourth and higher powers of the excentricity. The mistake has arisen from my confounding the azimuth of the station observed with the azimuth of the geodetical line connecting the stations at the place of observation. For the azimuth of the geodetical line at B we may take that of the point of intersection of the vertical line at D with the horizon of B. Calling B and D the azimuths of the geodetical line at B and D, it will be found that nearly $B-m = m'-D =$

$$e^2.(\sin\lambda-\sin\lambda')\sin m\,.\cos\lambda\,.\,\text{tang}\,\tfrac{1}{2}\beta,$$

and $\mu+\mu' = m+m'-\frac{e^4}{2}.(\sin\lambda-\sin\lambda')^2.\frac{\sin(m+m')\cos\lambda\,.\,\cos\lambda'}{\cos\frac{1}{2}\beta^2}.$

This value of $\mu+\mu'$ ought to be substituted in the exact formula

$$\text{Tang}\,\tfrac{1}{2}\omega = \frac{\cos\left(\frac{\lambda-\lambda}{2}\right).\,\text{cotang}\left(\frac{\mu+\mu'}{2}\right)}{\sin\left(\frac{\lambda+\lambda'}{2}\right)}$$

The three quantities $B+D$, $m+m'$, and $\mu+\mu'$, are consequently only equal as far as terms involving powers of the excentricity below the fourth are taken into account. As Mr. Ivory intends to deduce the value of ω expressed by the quantities m, m', λ, λ', e from the equations A of his paper, he will, no doubt, decide whether Dalby's expression for tang $\frac{1}{2}\omega$ or the same with his correction is more accurate.

Dec. 12, 1828. J. L. Tiarks.

VIII. *No-*

VIII. *Notices respecting New Books.*

The First Lines of Philosophical and Practical Chemistry, &c. By J. S. Forsyth, Surgeon, &c.

An opinion is generally prevalent among writers, that it is advantageous to them to possess some knowledge of the subject which they undertake to explain and illustrate; but unless the principles and practice of the maker of the book now under consideration are in direct opposition to each other, he entertains views on this subject totally different from those of most authors. Mr. Forsyth's great talent lies in copying; and though in the exercise of it, truth and error are in general equally welcome to him, yet in some instances, by a happy stretch of his powers, he contrives to expunge fact, and replace it by fancy. We shall not fatigue either ourselves or the reader with discussing the merits of Mr. Forsyth's arrangement: it is universally agreed to be a matter of secondary importance; never by its defects converting that which is in other respects a good book into a bad one, or by its lucidness rendering a middling performance excellent.

We have already hinted at our author's ignorance of chemistry; and that the charge may be closely followed by proof, we shall immediately proceed to offer it: a few instances taken at random will be sufficient for this purpose. In page 281 it is stated that "Blue verditer, much used for staining paper for hanging rooms, is a nitrate of copper combined with hydriate of lime." Now blue verditer contains neither nitric acid nor lime; and although by hydriate of lime, we presume our author's meaning (if he have any at all) to be hydrate, —this amendment of the spelling will be none of his chemistry; for any one in the least acquainted with the subject, knows that nitrate of copper is decomposed by hydrate of lime, and consequently that no compound of them can exist. It is, however, difficult to decide whether Mr. F's memory or judgement is most defective; for he had totally forgotten that at page 126 he had made the following statement: "the blue pigment called verditer, said to be prepared by decomposing the nitrate of copper by chalk, is an impure carbonate." Again, in page 281, "The beautiful grass green colour of the shops, called mineral green, is precipitated in a peculiar way from sulphate of copper by means of caustic potash and oxide of arsenic. The colour known by the name of Scheele's green, is an arsenite of copper." —Now it is evident, that the compiler of "The First Lines" is totally ignorant of the facts, that oxide of arsenic is another name for arsenious acid, and that mineral green and Scheele's green are similar compounds with different appellations. The oxalic acid (page 89) "crystallizes in slender flattened quadrilateral prisms, terminated by two-sided prisms." We have heard of prisms being terminated by pyramids; but to find prisms terminated by prisms, is something new in the science of crystallography; and we should be curious to see a model of a two-sided prism. With respect to chlorine, it is stated (page 96) that "it possesses no acid properties—it has not a sour taste—does not redden the blue colour of plants, and shows little disposition to unite

unite with the alkalies." Only fourteen lines lower down, however, our author has so completely forgotten what he had written, and is so totally destitute of facts to supply the deficiency of memory, that he not only allows chlorine to possess acid properties, but even asserts, that "it is the only acid that will dissolve gold and platina;" nor is this all, for he afterwards confounds chlorine with chloric acid, stating that "with various bases it forms salts called hyperoxymuriates."

Such, in our author's hands, is the fate of chlorine! In the space of less than twenty lines, chlorine is *not* an acid, and *is* an acid, and is another acid besides itself.

We trust we have now fully substantiated the charge of ignorance against the author of this work; and if any thing were wanting to complete the character of the book, we shall do it by the charge and proof of plagiarism—plagiarism the most unbounded. For this purpose let the reader take in hand Forsyth's First Lines, and Parkes's Rudiments of Chemistry (Third Edit. 1822), and to these works we shall refer him by the names of their respective authors.

Forsyth, page 82. "Most of the acids owe their origin to the combination of certain substances with oxygen, which has been called the acidifying principle."—Taken from Parkes, p. 101.

Forsyth, same page. "The substances which are combined with oxygen to form acids (in all decomposable acids) combustible substances. Indeed several of the acids are the product of combustion: witness the sulphuric, phosphoric, &c. Four of the metals, and all the other simple combustibles, except hydrogen, are convertible into acids."—Taken from Parkes, p. 101; except that by the omission of the word *are* before the sentence, *in all decomposable acids*, that which in the original is intelligible, is, in the intended copy, nonsense; and by stating that *four* only of the metals instead of *five*, and by excepting hydrogen, instead of saying, as in his original "hydrogen not excepted," Mr. Forsyth has converted truth into error, and convicted himself of ignorance.

Forsyth, page 83. "Some acids may be decomposed, and deprived of their oxygen; and others may be formed by a direct combination of oxygen with certain radicals."—Copied from Parkes, page 102; except that the word *artificially* is omitted after *formed*.

Forsyth, same page. "Some of these acidifiable radicals combine with different proportions of oxygen, and consequently produce different states of acidity. When two acids have the same radical, but contain different quantities of oxygen, they are distinguished by their termination. The name of that which contains the most oxygen ends in IC, the other in OUS. Thus we say *sulphuric* acid, and *sulphurous* acid, *phosphoric* acid, and *phosphorous* acid."—From Parkes, p. 102, literally.

Forsyth, page 85. "The mineral, the vegetable, and the animal kingdoms, all furnish bases or radicals, which become acids by their union with oxygen. The mineral acids are generally formed with a peculiar base and oxygen; the vegetable acids, with carbon, hydrogen and oxygen; while the animal acids are composed of the same substances

substances united with nitrogen. Some of the mineral acids are decomposable by charcoal heated to redness. Some of the vegetable acids are also decomposed and reduced into water and carbonic acid, by leaving them in an exposed situation to the action of their own principles: others may be changed into different acids, by imparting or abstracting a portion of oxygen. The animal acids are of all others the most liable to decomposition. In an elevated temperature, the carbon and oxygen unite to form carbonic acid, and the hydrogen and nitrogen to produce volatile alkali ..... there are substances possessing acid properties which contain no oxygen. Until lately there were only three acids whose composition was unknown; namely, the muriatic, the fluoric, and the boracic; these, however, have yielded to the power of Voltaic electricity, and their bases have been separated."

"The acids were formerly divided into three classes; namely, the mineral, the vegetable, and the animal acid; but the more useful and scientific way of dividing them is into two classes.

"1. The undecomposable, and those which are formed with two principles, are comprised in the first class; while those acids which are formed with more than two principles, compose the second. Those of the first class, which are formed with two principles only, are composed of oxygen and some other substance which is called their radical. The acids of the second class are composed chiefly of oxygen, hydrogen and carbon; though some of them contain a portion of nitrogen.

"*The acids of the first class are*—The sulphuric and sulphurous acids; the muriatic and oxygenized muriatic acids; the nitric, the carbonic, the phosphoric, and phosphorous; the fluoric, the boracic, arsenic, the tungstic, molybdic, and the chromic acids.

"*The acids of the second class are*—The acetic, the oxalic, the tartaric, the citric, the malic, the lactic, the gallic, the mucous, the benzoic, the succinic, the camphoric, the suberic, the lactic, the prussic, the sebacic, the uric, the amniotic and the fluoboric acids." This long quotation is, with a slight alteration or two, presently to be noticed, nearly all copied from pages 103, 104 and 105 of Parkes.—The changes which Mr. Forsyth has made in his original, are first, the substitution of *oxygen* for *this important agent*; 2ndly, the addition of *oxygenized muriatic acid* after *muriatic acid*, by which he has made a complication of blunders; 3dly, the omission of *arsenious acid*, which he ought to have retained, mentioning as he does the phosphorous as well as the phosphoric; 4thly, the omission of molybdous and telluric acids; 5thly and lastly, by mistaking the laccic acid for the lactic, he has twice included this latter acid in his second class.

Under the head of alkalies, the same spoliation has been carried on; we shall not so minutely examine the extent of the pilferings or of the blunders which have been made in copying. Mr. Parkes says the alkalies render the oils *miscible* with water.—Mr. Forsyth has converted this word into *durable*; and in many places throughout Mr. Forsyth's book, similar transformations are made. Thus in page 101, boracic acid is stated to be in the form of *thin salts*: we presume

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in his copy it stood *thin scales;* but probably having never seen boracic acid, he read the printer's blunder without being aware it was one. Again, in page 103, we are told that all soluble salts are more or less *rapid:* we have no doubt in the original it was *sapid;* but on reading his proof, Mr. F. knowing, perhaps, something more of medicine than of chemistry, concluded that it meant *rapid in their action.* But to return for a moment to the alkalies, a subject on which we shall not long detain the reader, not for want of opportunity, but because the appropriations are so similar to those which have been noticed with respect to the acids, that it would seem a twice told tale to enumerate them. There is, however, one circumstance which so completely illustrates Mr. Forsyth's scissors-and-paste-brush mode of book-making, that we must give it, in spite of the length to which our remarks have extended.

Contrary to our usual practice, we shall first quote from Parkes, (p. 83). "Formerly the fixed alkalies were considered to be *simple* substances, no one having been able to decompose them; but they are now found to be compound bodies.

"It will be recollected, that, in the first edition of the *Chemical Catechism,* written seventeen years ago, I offered this opinion of the compound nature of the alkalies. The galvanic experiments of Sir Humphry Davy *have confirmed the truth of this conjecture,* and proved beyond all doubt, that potash and soda are both metallic oxides."

Mr. Forsyth, bestowing more pains than he usually does in concealing the sources of his information, alters the passage we have quoted, thus, page 66. "Till latterly, the fixed alkalies were considered to be simple substances, in consequence of chemists not having been able to decompose them; but they are now known to be compound bodies." To this he has appended the following note: "The late galvanic experiments of Sir H. Davy *have confirmed the truth of this conjecture,* and proved, beyond all doubt, that potass and soda are both metallic oxides." In these quotations we have put some words in italics; and these prove such to be the undiscriminating haste with which Mr. Forsyth appropriates the language of others, that he had forgotten that the conjecture to which he alludes, was Mr. Parkes's, and not his own.

An Account of an Egyptian Mummy, presented to the Museum of the Leeds Philosophical and Literary Society, by the late John Blayds, *Esq. Drawn up at the request of the Council, by* William Osburn, Jun., F.R.S.L., *Secretary to the Society: with an Appendix, containing the Chemical and Anatomical Details of the Examination of the Body. By* Messrs. E. S. George, F.L.S., *Secretary to the Society;* T. P. Teale; *and* R. Hey. Leeds, 1828, 8vo, pp. 51: 5 lithographs.

After an attentive perusal of this work, and a minute comparison of the details it contains with those of Dr. Granville's elaborate memoir on the art of embalming among the ancient Egyptians*, we cannot

* Phil. Trans. 1825; abridged in Ann. of Phil. N.S. vol. xi. p. 215; and in Phil. Mag. vol. lxvi. p. 70.

but regard it as a very valuable contribution to the study of Egyptian antiquities; as throwing much new light on the processes to which that singular people were accustomed to subject the bodies of their dead, and as vindicating the authenticity, on this point, of the venerable historians to whom we have hitherto been chiefly indebted for our knowledge of the early history of Egypt. The information communicated by Messrs. Osburn and George and their coadjutors, respecting the specimen of Egyptian embalming which they have examined, illustrates many important particulars discussed in Dr. Granville's paper; while the condition of the mummy so well described by that physiologist, affords, in its turn, the means of confirming and explaining many circumstances attending the former. In a train of researches upon a single mummy, it was probably impossible for either Dr. Granville or the gentlemen of the Leeds Society, to avoid forming erroneous conclusions on some minor points of the inquiry; but the works they have respectively produced mutually explain and correct each other in these respects. The improvement which the pursuits of the natural philosopher and those of the antiquary may reciprocally impart to and receive from each other, is also evinced in an interesting manner by contrasting these two publications. Dr. Granville, by the anatomical examination to which he subjected the mummy in his possession, and the chemical experiments he subsequently instituted, succeeded in discovering the process by which the Egyptians, at a period no less distant than three thousand years, had effected its preservation. Mr. Osburn, on the other hand, by deciphering the hieroglyphical inscriptions on the case or coffin of the mummy belonging to the Leeds Society, and ascertaining the name and occupation of the person embalmed, and the time at which he lived, has imparted to many of the probable inferences drawn from the physical history of both specimens, the solidity and precision of actual knowledge.

The interest excited by researches like the present, depends, in great measure, upon circumstances peculiar to the archæology of Egypt, which requires for its investigation the united labours of the philologist, the historian, and the naturalist. These circumstances have originated, principally, in the singular and complicated system of mythology entertained by the Egyptians; in which all nature, animate and inanimate, was called upon to bear a part, either as a manifestation of deity, or as a symbol of superstition.

> "Quis nescit, Volusi Bithynice, qualia demens
> Ægyptus portenta colat? Crocodilon adorat
> Pars hæc: illa pavet saturam serpentibus ibin.
> Effigies sacri nitet aurea cercopitheci,
> Dimidio magicæ resonant ubi Memnone chordæ,
> Atque vetus Thebe centum jacet obruta portis.
> Illic cæruleos, hic piscem fluminis, illic
> Oppida tota canem venerantur, nemo Dianam.
> Porrum et cæpe nefas violare, et frangere morsu.
> O sanctas gentes, quibus hæc nascuntur in hortis
> Numina!"
>
> JUVENAL, Sat. xv.

But with this mythology, debased and absurd as it must have been as a system of religious belief, was necessarily interwoven an extensive

sive knowledge of natural objects, their forms and their intimate qualities, significantly termed in Holy Writ "the wisdom of Egypt." And this knowledge appears to have been the remains in one branch, as the mythology was the entire perversion in another, of the higher wisdom enjoyed by the progenitors of the Egyptians, who had united their knowledge of nature to the perception "that things *in* nature were symbols of things *above* nature, and of the attributes and glory of the Godhead*."

In this train of circumstances, possibly, may appear one of the reasons why the secret of deciphering the Sacred Characters employed by the Egyptian priests, which the learned in all ages, from a period even long anterior to the revival of letters, had in vain sought to discover; and all successful research into Egyptian antiquities, should have been reserved for the present century, when the knowledge of nature, in every department, has become so extensive and so exact; and why also, after mere philologists of the highest reputation had failed in their efforts, a natural philosopher of profound attainments should have been the first to interpret the Hieroglyphics.

The investigation of Egyptian antiquities has already furnished materials for some important contributions to Natural History, and to the physical history of man. Examples of this fact may be found in the researches of Cuvier on the sacred Ibis; in those of Geoffroy de St. Hilaire on the *Suchus*, or sacred Crocodile, from which has resulted the knowledge that a small species of crocodile exists, or has existed, in the Nile, distinct from *Crocodilus vulgaris*; and in the examination by the former naturalist of the heads of many Mummies, on which he founded his opinion respecting the Caucasian origin of the Egyptians,—an opinion strongly confirmed by the form of the head, and the exquisite proportions of the body, in the female mummy described by Dr. Granville. The study of these antiquities, however, has not assumed its appropriate rank as a branch of general knowledge; and they are best known, as yet, through the interest attached to them in the enterprises of Belzoni and his associates. On this account, as well as for reasons which will be evident in the sequel, we shall be more particular in noticing the archæological contents of the work before us, than might otherwise have been expedient in a Journal devoted to the objects of natural science.

It is stated by the Council of the Leeds Philosophical Society, in the "Advertisement" preceding Mr. Osburn's memoir, that so many new, and in their opinion important facts presented themselves during the process of unwrapping the mummy, that they conceived they should have been wanting to the interests of the Society had they forborne to make them public. Coinciding altogether in the propriety of this measure, we shall now proceed to give an analytical account of the memoir; and afterwards to substantiate, by a

* See Kirby and Spence's Introduction to Entomology, vol. iv. p. 403, and p. 360—410.

few details of a scientific nature, the opinion of its merits, with which we have commenced this review.

The mummy described in the work now before us was sent to London from Trieste, to which place it had probably been transmitted from Egypt by that celebrated spoliator of the Egyptian sepulchres, M. Passalacqua. It was inclosed in a coffin of sycamore, covered with paintings and hieroglyphical inscriptions, which retained much of their original brilliancy of colouring. Beneath the coffin-lid, which represented a recumbent human figure, and fitted closely to the bandages of the mummy, was another wooden covering, also representing a man, and decorated with hieroglyphics. The whole of the swathings were secured by bandages of linen, wound obliquely about the body for five or six thicknesses; beneath these were broader bandages of coarser linen. On unwrapping one or two of the folds, a wreath or fillet of intricate flower-work was discovered on the breast, exactly resembling the collars constantly represented round the necks of Egyptian figures. The removal of a few more folds disclosed another singular ornament upon the bandages of the head and face. This consists of three straps of red leather, to which is attached a smaller piece of the same material, precisely corresponding in outline to the form of certain amulets in basalt, found by Belzoni in the tombs of the kings at Biban-el-Malouk, and like them covered with hieroglyphics. "The figures and hieroglyphics upon this ornament," Mr. Osburn observes, "are evidently the impressions of heated metal types." On continuing to unwrap, several larger pieces of linen were found, merely laid upon the body, of all the three different textures of cloth which were found about the mummy. One of the finest was a perfect garment, of a very simple form, answering exactly to the Egyptian garment described by Herodotus under the name of *Calasiris*. The arms of the mummy, which were now visible, are slightly bent at the elbows, so that the hands meet in front; they were closely swathed in linen from the shoulders to the tips of the fingers. The unwrapping of the few folds now intervening between the arms and the body, exposed a thick layer of spicery, consisting of pounded myrrh and cassia, which was found to be interposed everywhere between the bandages and the skin.

The body is in an unusually perfect state of preservation. The outer skin, which is not removed as in the mummy examined by Dr. Granville, is of a livid gray colour, soft and greasy to the touch, and, as well as the flesh, has some resemblance to adipocere. The features appeared shrivelled, but not otherwise at all injured, except by slight compressions on the forehead and bridge of the nose, which seem to have been occasioned by bandages drawn tightly across the face while in a soft state. The head, eyebrows, and beard, have been closely shaved, a circumstance agreeing with the ordinances of the Egyptian priesthood, as recorded by Plutarch and Herodotus. The contents of the trunk had been removed through an incision on the left side of the abdomen; every thing was cleared away, even to the great vessels which run along the spinal column; but the heart, the liver, and the kidneys, after being embalmed, had

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been wrapped separately in fine linen, and placed in the left side of the thoracic cavity.

"It is well deserving of notice," Mr. Osburn remarks, in concluding this part of the subject, "that the extraction of the brain through the nostrils, the incision through which the vitals were removed on the left side of the body, the cavity filled with a mixture of spices, amongst which are myrrh and cassia or cinnamon, the use of natron in the conservative process, and finally the wrapping of the body in bandages of cloth dipt in gum, are all the particulars related by Herodotus and Diodorus Siculus concerning the first and most expensive mode of embalming amongst the Egyptians, and that every one of them is exemplified in the mummy we are now describing."

This portion of the work is followed by an account of the mythological paintings which decorate the coffin and coffin-lid, as well as the upper part of the inner wooden covering. In explaining these devices, as well as in deciphering the inscriptions with which they are mingled, Mr. Osburn altogether follows the system of M. Champollion, being entirely convinced, he observes, of the correctness of the principle upon which it is founded. At the head of the coffin is the goddess Isis, accompanied by the four genii of *Amente*, (the Egyptian Tartarus, or place of separate spirits,) commonly called the four *Canopi*. The sides are each divided into ten compartments or *shrines*, every one of which contains the representation of one or more Egyptian divinities, having an altar with offerings before them, and a hieroglyphical inscription, consisting of a prayer addressed to them on behalf of the deceased. On each side of the head is the god whose hieroglyphical name is *Ptah Socri*, or Φθα, as written by the Greek authors, accompanied by his wife *Hathor;* these answer respectively to the Ἡφαιστος or Vulcan and to the Venus of the Greek mythology. All these figures Mr. Osburn explains in detail. At the foot of the coffin is the symbol of *Ptah*, called the Nilometer, and on each side of it are the sister goddesses *Isis* and *Nephthys*.

The devices upon the lid are also very numerous. Upon the throat is the Scarabæus with extended wings, and along the arms are a number of sitting figures, probably representing part of the forty-two assessors of Osiris, in his character of lord of Amente and judge and king of souls. Immediately below the arms is the ship or bark of the Sun resting upon the symbol of heaven, which is in its turn supported by the outstretched wings of the goddess *Netpe* or Rhea, who is represented in a kneeling posture immediately beneath it. Three long inscriptions extend from the waist to the end of the toe. From these, transverse bands of hieroglyphical inscriptions pass to a similar inscription round the edge of the lid, dividing the spaces on both sides into five compartments, in each of which the deceased is represented worshipping different divinities. All these devices are particularly described in the work.

The god *Thoth*, or Hermes, called, in the accompanying hieroglyphical text, "*Thoth, Lord of Sacred Characters*," is represented three times on the coffin and twice on the lid, in his office of intercessor

cessor with the other deities on behalf of the deceased. This is accounted for by the profession of the embalmed person, which was that of a sacred scribe, as will presently be explained.

The hieroglyphical inscriptions on mummy-cases in general, Mr. Osburn informs us, are precatory addresses to different divinities on behalf of the individuals inclosed in them; and as the same mythological blessings would be required for the soul of every deceased person, these inscriptions principally consist of a series of formulæ, which are repeated under different combinations, and in forms more or less abbreviated, upon all similar monuments. According to Champollion they are extracts from what is named in hieroglyphics "*The Book of Gates concerning the Manifestation to Light*," parts of which are to be found on all the papyri deposited in mummy-cases, but the entire transcription of which is more than fifty feet in length.

"This immense collection of liturgical formularies and prayers was a complete guide-book to the soul after its separation from the body, describing the various regions of the infernal and celestial worlds through which it should pass, the adventures it would meet with, the divinities to be appeased, and the sacrifices and prayers to be offered before it reached the judgment-seat of Osiris in Amente, and finally the regions of everlasting bliss." Accordingly the hieroglyphical inscriptions on the mummy-case here described by Mr. Osburn, are prayers addressed on behalf of the deceased to the different divinities whose representations they accompany, and the blessings besought are suited to the perilous journey on which, according to the notions of death held by the Egyptians, he had set out, and to the change of nature he had to undergo before he could be admitted into the mansions of eternal happiness.

The blessing of understanding or intelligence is besought of the goddess *Selk*, whose symbol is a scorpion, and also of *Ptah Socri*. The latter, together with an unknown deity, is supplicated for "that participation of the nature of the gods, to which, according to the Egyptian psychology, the departed spirits of just persons were admitted;" no English word, Mr. Osburn observes, so nearly conveying its meaning as *regeneration**. The god *Soou* is asked for "*intellectual regeneration*". The gods *Tore* and *Benno* are besought that divine

* It is with much deference to Mr. Osburn that we venture to state our dissent from his opinion on this subject: but the use of the term regeneration, as nearly equivalent, in the English language, to the group of phonetic hieroglyphs expressed by the letters HoRT, tends, we conceive, by introducing an erroneous idea, to confuse our notions on an important dogma of the Egyptian religion, which is in itself sufficiently intricate and difficult clearly to apprehend.

The primitive signification of the term *regeneration*, as employed in the New Testament, and ascertained by a comparison of the passages in which the subject is mentioned, is simply a new formation of the spirit of man effected, essentially, by Divine power. According to this signification, or in some sense derived from or agreeable to it, this term is understood by every denomination of Christians who attach to it any definite meaning. It never means a *participation* in the Divine nature such as it is in itself, but merely a con-

divine honours might be received by the deceased; *Anubis* and the goddess *Netpe* are implored to grant him participation in the nature of Osiris; and the same goddess is besought that he may receive sacrifice. The goddesses *Nephthys* and *Tafnet* are supplicated to bestow upon him *the ensigns* called *Bathmi*, which are borne by *Kebh-Sniv*, one of the ministering spirits of Osiris, and *all the other blessings, or benefits, of a minister* of that deity.

After thus deciphering these inscriptions and the symbols which they accompany, Mr. Osburn proceeds to explain those which denote the proper name, and rank, and occupation of the embalmed person. The researches of Dr. Young, confirmed by those of M. Champollion, enable him to do this with considerable facility and certainty. The name is repeated fifty times upon the coffin, with a single variation only in the characters expressing it; but the groups denoting the rank and occupation of the deceased differ totally in different prayers. It appears from the whole, that the person whose embalmed body is now deposited in the Leeds Museum, was NATSIF-AMON, incense-bearer and scribe of the shrine of the god Mandoure, and also scribe (or clerk) of the provender of the sacred bulls in the temple of Amon-Ra at Thebes.

Mr. Osburn terminates his portion of the work with an account of the hieroglyphics on the ornament of red leather found on the head of the mummy. The data contained in M. Champollion's works, applied to the devices on this ornament, show that they express the name of the monarch during whose reign Natsif-amon died and was embalmed. This monarch was Remesses V., (the father of Sethos-Remesses, or Sesostris,) whose reign, according to the chronological calculations of M. Champollion-Figeac, commenced in the year 1493 B.C. and lasted nineteen years and six months. The date of the mummy is therefore carried back nearly 3300 years from the present time.

The first article in the Appendix is Mr. George's chemical exami-

a conversion to that state of mind in which man is regarded to bear a finite analogical resemblance to the Divine character.

The Egyptians, however, as Dr. Young has shown, believed that the departed spirits of just persons became divinities *themselves*; an example of which belief is afforded by the inscriptions on the mummy-case described by Mr. Osburn, and mentioned in the text above, in which various pre-existent deities are supplicated for blessings which necessarily involve the reception of the deceased into co-equality of nature with themselves. Does it not appear, therefore, that the sense of the hieroglyphic group in question can only be correctly expressed by the term *apotheosis* or *deification?*

This deification, as is well known to the cultivators of Egyptian literature, was not to be a participation in the divine nature, such as it was supposed to be possessed by all the original or pre-existent gods indifferently, but an admission, specifically, to the nature of *Osiris*. With the previous knowledge of this circumstance, Mr. Osburn's remarks on the hieroglyphic group HoRT seem to afford the means of obtaining some definite ideas of the mythological process by which this apotheosis was imagined to be effected. But as this subject is foreign to the design of the present article, and would require a detailed explanation, we must reserve it for another place.

nation

nation of some portions of the mummy and the substances connected with it, which was given entire in the Phil. Mag. and Annals for October last; N. S. vol. iv. p. 290.—The second article, concluding the work, consists of an anatomical examination of certain parts of the mummy, by Messrs. T. P. Teale and R. Hey. From this we extract the following particulars: The cranium was covered by an easily-separable layer of dry animal matter, and in some parts a few short hairs were distinguishable. The dura mater was found, well-preserved, in its natural situation. The cavity of the cranium was rather more than half filled with the same spices as those found outside the body, among which were a few lumps of resinous matter. The brain itself appeared to have been removed through an opening made by an instrument passed through the right nostril and driven forcibly through the thin layers of the sphenoid bone in which the sphenoidal cells are situated. The eyes were in their natural situation; "the incisor teeth, both of the upper and lower jaw, were short, cylindrical and truncated, having a broad, horizontal, and nearly circular base, which appeared worn by attrition." The tongue appeared to have been spread out when soft; the cavity of the mouth was filled with the spices like that of the cranium. "The general contour of the cranium and face differed from the European in the greater prominence of the jaws, and the depression of the forehead." On the left side of the abdomen was an incision extending from the cartilages of the ribs to the crest of the ilium. The cavity of the abdomen was also filled with the aromatics, and not a vestige of its viscera could be found; but a small portion of the diaphragm remained. In the left side of the chest were deposited, separately inclosed in linen, as before mentioned, the kidneys, the liver, and the heart. The fractured surface of the two latter resembled that of glue. The trachea occupied its natural situation, and to it adhered what seemed to be part of the lungs; the remainder of the thorax was filled with the spicery. A dissection being made of the soft parts at the back of the pelvis, the glutæus maximus muscle was dissected from the ilium and reflected: the muscular fibres yielded a little to the finger, were of a deep brown-red colour, and were slightly translucent. The sciatic nerve was dissected out, and easily traced upwards to its several origins.

Such is the series of antiquarian, chemical, and anatomical researches constituting this work. The results throughout are of a very satisfactory character; and the facts elicited are related by all the writers in the simple and unpretending manner which so well becomes the true votaries of science. Mr. Osburn has brought to his subject commensurate zeal and knowledge of Egyptian antiquities: and the argument by which he refutes the only objections which could with any plausibility be urged against the conclusion, that the monarch during whose reign Natsifamon died was Remesses V., and by which, consequently, the precise date of the mummy is established, we deem as perfect and as irrefragable an example of archæological induction, as can be found in the history of any period or of any nation. It might almost be said, in allusion to this

this and to some similar instances which occur in the hieroglyphical researches of Dr. Young, that the granite monuments of Egypt had imparted their own firmness and solidity to the conclusions drawn from the records which have been sculptured upon them, or deposited within their recesses.

Five lithographs from the pencil of Mr. Denny, the Sub-Curator to the Society, illustrate this "Account:" the frontispiece represents, on a greatly-reduced scale, one side of the coffin and lid, the long inscription on the latter, and the inner covering of the mummy; in plate 2. are depicted, we presume of the actual dimensions, the inscribed ornaments of red leather found on the bandages of the head and face; plate 3. contains the various formulæ in which the name of the embalmed person is included, and plate 4. the precatory inscriptions, all reduced; plate 5. illustrates the anatomical examination, representing one of the kidneys, the heart, and the liver. All are neatly, and we doubt not faithfully executed; but the Anatomist, perhaps, might desire to have seen greater minuteness of detail in the last-mentioned plate; and the draughtsman has omitted to attach a scale of dimensions to the reduced figures. [B.]

[To be continued.]

IX. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

NOV. 20, 1828.—A paper was read on a Method of rendering Platina malleable. By Wm. Hyde Wollaston, M.D. F.R.S., &c.

In this paper the author details the processes which, from long experience in the treatment of platina, he regards as the most effectual for rendering that metal perfectly malleable. When it is purified by solution in aqua regia, and precipitation with sal ammoniac, sufficient care is seldom taken to avoid dissolving the iridium contained in the ore by due dilution of the solvent. The writer states the degree of dilution requisite for this purpose, and the exact proportions in which the acids are to be used. The digestion should be continued for three or four days, with a heat which ought gradually to be raised; and the fine pulverulent ore of iridium allowed to subside completely before the sal ammoniac is added. The yellow precipitate thus obtained, after being well washed and pressed, must be heated with the utmost caution, so as to expel the sal ammoniac, but at the same time produce as little cohesion as possible among the particles of platina. It is then to be reduced to powder, first by rubbing between the hands, and next by grinding the coarser parts in a wooden mortar with a wooden pestle, because the friction with any harder surface would, by producing burnished surfaces, render them incapable of being welded together by heat. The whole is then to be well washed in clean water. In this process, the mechanical diffusion through water is made to answer the same purposes as liquefaction by heat in the case of other metals; the earthy impurities being carried to the surface by their

superior lightness, and the effect of fluxes being accomplished by the solvent powers of water.

The gray precipitate of platina being thus obtained in the form of a uniform mud or pulp, is now ready for casting, which is effected by compression in a mould, formed of a brass barrel, six inches and a half long, and turned rather taper within, so as to facilitate the extraction of the ingot when formed. The platina is first subjected to partial compression by the hand with a wooden plug, so as to expel the greater part of the water. It is then placed horizontally in an iron press, constructed so as to give great mechanical advantage to the power applied to produce compression. The cake of platina is then to be heated to redness by a charcoal fire, in order to drive off all the remaining moisture; afterwards subjected to the most intense heat of a wind furnace; and lastly, struck, with certain precautions, while hot, with a heavy hammer, so as effectually to close the metal. The ingot thus obtained may, like that of any other metal, be reduced, by the processes of heating and forging, to any other form that may be required. It may then be flattened into leaf, drawn into wire, or submitted to any of the processes of which the most ductile metals are capable.

The perfection of the above method of giving complete malleability to platina is proved by comparing the specific gravity of a fine wire of that metal obtained by this process, which is found to be 21·5, with that of a similar wire drawn from a button which had been completely fused by the late Dr. Clarke, with an oxy-hydrogen blowpipe, and which the author ascertained was only 21·16. A further proof of the excellence of the method employed by the author is derived from the great tenacity of the platina thus obtained, as determined by a comparison of the weights required to break wires made of this metal so prepared, and similar wire of gold and of iron. These weights he found to be in the proportion of the numbers 590, 500, and 600, respectively.

An account is subjoined of the process for obtaining malleable palladium, by the intermedium of sulphur; and also of that for procuring the oxide of osmium in a pure, white, and crystallized state.

Dec. 1.—At the Anniversary Meeting of the Royal Society, on St. Andrew's day,—after the names had been read of all Members deceased in the preceding year, and before the Medals were delivered, Mr. Davies Gilbert (President) addressed the Society to the following effect.

It would be vain to expect that the anniversary meeting of a body so numerous as the Royal Society should ever occur, without exciting in our minds sensations of deep regret for the loss of many individuals distinguished by their abilities, by their acquirements, by their virtues, and endeared to other members by the ties of private friendship. We may also add, with feelings of exultation in regard to the honour of the Society, however painfully they may bear upon ourselves, that the number of those among us sharing in our active labours, far exceeds the limit that might justify a hope of our not being called on to deplore some of these more conspicuous Fellows of the Society on the present occasion.

Although

Although it is usual chiefly to dwell on the names of those have enriched the Transactions by their communications, yet some occur in the list now read, whom it is impossible to pass over without notice.

Mr. Archdeacon Cox, whose name will go down to posterity, associated with those of many illustrious persons whose histories he has diligently investigated and adorned.

Major Denham, whose active exertions, perseverance, and untimely fate, can scarcely be contemplated without a tear.

The Rev. Alexander Nicoll, Regius Professor of Hebrew in the University of Oxford,—a man most eminent in the literary pursuit he had selected, and advanced to the high station of Professor by the disinterested regard for merit of an individual still living, and who at the time held the most confidential office in the government of this country. Much certainly was expected from Mr. Nicoll in the recondite learning appropriate to his station; and if the experience of past diligence and acumen may be taken as an assurance of future active exertion, these expectations would not have been disappointed. But he is lost to us at an early age.

Mr. William Phillips has not, indeed, appeared in the Philosophical Transactions; but his labours have assisted the inquiries of geologists and mineralogists in every part of the world. In English geology he contributed a joint share towards a work, unfortunately not yet complete, but confessedly the most luminous and accurate that has hitherto appeared. And in crystallography, those alone who have made some progress in that most beautiful yet intricate science, are capable of appreciating the extent of his merit.

The first name that presents itself from the Transactions is that of Mr. Mills, to whom we are indebted for a geological communication on the wyn dykes, and on the basalt of Scotland and Ireland, so long ago as in the year 1790; at a period when that science, the distinguishing glory perhaps of the nineteenth century, had scarcely acquired a distinct appellation in our language.

Dr. John Mervin Nooth, elected in 1774, had favoured the Society in the preceding year with some theoretical and practical observations on electricity, one of the sciences then most attractive of general curiosity, in consequence of the wonderful discoveries recently made by Dr. Franklin; and in 1775, excited by the no less important experiments of Dr. Priestley, he supplied our Transactions with the description of an ingeniously contrived apparatus for saturating water with carbonic acid, or, as that gaseous fluid was then called, with fixed air. On the first discovery of carbonic acid as a distinct and peculiar substance, followed by an analysis of its constituent parts, great medical virtues were imputed to it,—much greater than subsequent experience has confirmed. Under these first impressions, the instrument invented by Dr. Nooth was eagerly seized, and might be seen in most private houses. The elegant pyramidal form of its three parts ascending one above the other, and displaying by their transparency the whole process as it goes on, is still exhibited by druggists and by manufacturers of glass. Many gentlemen who now hear me

will share in the surprise which I felt on learning that the inventor of an apparatus familiar to my childhood, should have lived to be commemorated in the present year.

We have next to notice a gentleman elected some short time prior to Dr. Nooth, about fifty-five years ago, known to our Transactions, indeed, by a single paper on antiquarian philology, but well known to the Society by the able discharge of the duties attached to one of its most important offices for a space of twenty-eight years. Mr. Planta was chosen a fellow in 1774; he became secretary in 1776, and continued to execute that office with great ability and diligence up to 1804. It is needless for me to dilate on his merits as principal librarian at the British Museum,—they are universally felt and acknowledged.

Dr. Sir James Edward Smith is known in every country and in every place over the whole civilized world, where natural history is cultivated as a science. Dr. Smith, having added to the usual accomplishments of a polite scholar an extensive acquaintance with botany, took, at an early period of his life, the decisive step of acquiring the Herbarium of the great Linnæus, augmented by his son. The purchase was made in Sweden, after the government of that country had declined to buy, at a moderate price, the most precious relict of its most distinguished subject; and, by so doing, to rescue from difficulties those in whose welfare this illustrious reformer of natural history had been most nearly interested. Dr. Smith embarked his acquisition, and after escaping a danger the last to be apprehended, and which, from respect to a country of literature and of science, I shall not describe, the collection was landed in England, where full security and protection afforded the proprietor leisure for making that use of the collection which has so amply established his fame. Soon afterwards, Dr. Sir Edward Smith most fortunately employed himself in kindling a separate light from the illustrious body I have now the honour to address; and several others having since followed in a similar manner, they are now spreading a brilliant illumination over the whole horizon of science; while, so far from obscuring, they continue to increase the lustre of their parent flame. What, therefore, this distinguished naturalist has done for the Linnæan Society, we may in some degree consider as done for ourselves. We have one ingenious communication in our Transactions for the year 1788, on the irritability of vegetables. Not satisfied with discharging the duties incident to the presidency of his own Society, and with investigating and verifying the Linnæan specimens, by comparing them with recent plants, with other dried specimens, with figures, and with descriptions, his time and attention have been also employed in editing one of the most splendid works ever published in this country, the Flora Græca of Dr. Sibthorpe. For various smaller works on the philosophy of natural history, on the natural orders, &c. we are indebted to his pen. And, to close a life of literature and science like that of Dr. Sir James Smith, the last volume of his English Botany (a work of great accuracy and merit) appeared in London on the very day that proved to its author the termination of his mortal career; not of

a length commensurate to our wishes, but splendid and useful to the utmost expectation of his warmest friends.

Another distinguished member of this Society has recently been taken from us, by one of those accidents, common indeed to old age, yet of a nature to excite compassion, or feelings perhaps of a stronger cast. Dr. George Pearson was elected in June 1791, and he has enriched our Transactions with ten communications. The first, in the year of his admission, on Dr. James's antimonial powders. The composition of this celebrated febrifuge having been long withholden from the public, notwithstanding the sworn specification of its inventor, a great anxiety was naturally felt for discovering the secret. This, Dr. Pearson effected, having proved by analysis, and by the reunion of the constituent parts, that antimony and phosphate of lime made up the whole mass. Some slight differences may still exist between the concealed medicine and any other that can be produced, arising probably from peculiar, and possibly accidental and unimportant manipulations; but no doubt can be entertained as to the essential ingredients. The second, in 1792, on the composition of fixed air. The third, in 1794, on a peculiar vegetable substance, imported from China. The fourth, in 1795, on the nature and properties of wootz, iron and steel made in the East Indies. The fifth, in 1796, is a paper equally interesting to the natural philosopher and to the antiquary, since it ascertains the composition of metallic weapons belonging to times the most remote, and confirms the opinion, derived from classical authority, of their being made from an alloy of copper and tin. The sixth, in 1797, on the nature of gas, produced by passing electric sparks through water. This communication must be highly estimated, since it tended, at that early period, strongly to confirm the great discovery of Mr. Cavendish—the decomposition of water; a discovery of the utmost importance, but requiring every possible confirmation, as it went in direct opposition to the decided opinions, to the prejudices of many thousand years. We are become familiar with hydrogen, with oxygen, with the compound nature of liquids, and the changes of form produced on bodies by the agency of heat. The speculative philosophers of antiquity, on the contrary, mistaking varieties of form for real differences of substance, arranged all physical nature under four classes, denominating solid bodies, or the principle of solidity, earth; liquid bodies, under a similar hypothesis, water; and the principle of elasticity, air; fire, or heat, occupied the fourth division: and to these was added a fifth, or quintessence,—the substance endowed with consciousness, with thought, and with the power of originating motion. It is obvious that ice, water, and steam, to satisfy this arrangement, must possess three distinct essences; yet such is the power of habitual attachment to opinions never before questioned, that had Mr. Cavendish, the scientific ornament of our country and of his age, lived some centuries before our time, he might perhaps have experienced a common fate with the philosopher who maintained the revolution of the earth and the central position of the sun. The seventh, eighth, and ninth communications, in subsequent years, are strictly professional; and the tenth, in 1825, also medical, relates

relates to a black colouring matter occasionally found in the bronchial glands. But Dr. Pearson has still further claims on our respect and our regard. For a series of years he continued to diffuse, by his lectures, a knowledge of the new chemistry, instructing hundreds in the truths of science, as they became successively developed, in a manner not calculated to load the memory, but to invigorate the reasoning powers, in proportion as new facts were communicated and arranged. And to Dr. Pearson we are again indebted for rendering familiar in England the nomenclature of chemistry, first adopted in another country; an adaptation of words to things, of which it may be truly said,

Ὁς αν ειδῃ τα ονοματα, εισαται και τα πραγματα.

A medium of communication adapting its plastic nature to the reception of new facts, and of new arrangements, owing, perhaps, their existence to the facilities of this universal language.

One individual it still remains for me to notice, and with deep regret; for, considering the number and the value of his communications, together with the pre-eminence of the science on which his energies were employed, it may fairly be said that no greater loss has been sustained by the Society within the period to which we refer, than it has experienced by the death of Professor Woodhouse. We have from him seven different papers,—four on abstract and profound mathematical speculations; the last three on subjects connected with the recently established Observatory at Cambridge. Born with strong abilities, and with a predisposition for the investigation and the acquirement of abstract truth, Mr. Robert Woodhouse cultivated mathematics with great assiduity, and with a corresponding success. Having attained the highest academical honours, he mainly contributed, by his writings in our Transactions, by various separate publications, by his example, and by the influence of his official situation in the University—towards paying that true homage to Newton which has, of late, been rendered to him, in the very focus of his glory,—not by servilely adhering to methods or to forms, the devising of which by one man will always continue the wonder of the human race;— but by doing as Newton himself would have been most eager to do; that is, by raising still higher the edifices of which he has laid the solid, the everlasting foundations. And sure I am that Mr. Woodhouse would accept as the most gratifying tributes to his memory, the appointment and the exertions of such a successor as the distinguished person (whom I would willingly enumerate as one of us) now actually engaged in carrying towards perfection these matters, of which the commencements only were permitted to himself.

And here I would call your attention to the loss sustained by the world at large, in the person of another philosopher and Fellow of this Society, although not a contributor to our annual publications—Mr. Dugald Stewart, imbued with a taste for mathematical learning by his father's eminence in that department of knowledge, has done more than almost any one of his contemporaries towards freeing from mystery and paradoxes the science which should naturally be of all the most clear and precise. Following the steps of Bacon and of Locke,

Locke, and stored with an extent of reading and of acquired knowledge almost beyond example, there can be found few subjects which he has not illustrated; and in respect to conclusions which seem to differ from the deductions of his great predecessors, his arguments are so fairly stated on either side, that every intelligent reader is placed in a situation to form his own opinion on those profound and abstruse points. Mr. Stewart has somewhere quoted—Μειζον εστι το δυναμιν αναλυτικην κτησασθαι του πολλας αποδειξεις των επι μερους εχειν. And, "Mathematica multi sciunt, Mathesin pauci. Aliud est enim nôsse propositiones aliquot, et nonnullas ex iis elicere, casu potius quam certâ aliquâ discursandi normâ, aliud scientiæ ipsius naturam ac indolem prospectam habere, in ejus se adita penetrare, et ab universalibus instructum esse præceptis quibus theoremata ac problemata innumera excogitandi, eademque demonstrandi facilitas comparetur. Ut enim pictorum vulgus, prototypon sæpe sæpius experimendo, quendam pingendi usum, nullam verò pictoriæ artis, quam optica suggerit, scientiam adquirit; ita multi, lectis Euclidis et aliorum geometrarum libris, eorum imitatione, fingere propositiones aliquas ac demonstrare solent, ipsam tamen secretissimam difficiliorum theorematum ac problematum solvendi methodum prorsus ignorent." By reverting to the long-neglected controversies of the Nominalists and the Realists, and by adopting the theories of a most acute and subtile reasoner, who for centuries past has been remembered (such is the caprice of Fame) by a reference only to the frailties and to the misfortunes of his youth, this able metaphysician has either fully explained, or has pointed out the method of explaining, every difficulty which seemed to obstruct the use of imaginary quantities. And by pursuing the same track—if ancient prejudices, derived from far different speculations, could once be banished from our minds—it would soon be found that all circumlocution for avoiding the terms infinitely small, infinitely great, and even orders of infinites, might be dismissed from mathematical language, without producing uncertainty, mystery, or confusion. I consider, therefore, Mr. Dugald Stewart as a distinguished writer in the higher departments of mathematics, and *eo nomine* entitled to our respect and our regard.

On the foreign list we find the name but of one individual whose loss we have to regret in the past year, M. Thunberg of Upsal.

M. Thunberg, a pupil of the great Linnæus, "one of the few remaining companions of the prophet," has continued throughout a long life to cultivate a science which Sweden must consider as her peculiar glory. His labours are perhaps little known in this country at present; but at a period when botany stood more pre-eminently forwards,—about forty years ago,—M. Thunberg was chosen on our foreign list.

On delivering the Medals.

Of the duties devolved on those Fellows of the Society whom in any particular year you may honour by naming on your Council, none are equally arduous with the distribution of your medals. If the requisite inquiries were limited to discovering able men, ingeniously contrived experiments, or valuable communications, the task would

would be easy indeed; these might be found at every meeting of the Society, in every page of your Transactions. But the medals are evidently meant to distinguish somewhat more; so that he who receives them may at the least be considered as *primus inter pares* with respect to the particular subject of his attention.

One of the royal medals your Council of this year have had no hesitation in adjudging to M. Encke for his researches and calculations respecting the heavenly body usually distinguished by his name, and which has again become visible in Europe, according to his prediction; and not merely visible, but corresponding with its estimated position in declination as well as in right ascension, to a degree of accuracy scarcely susceptible of correction, unless by repeated observations. This body, to be denominated a planet or a comet, according to the variety of definition, revolves round the sun in an elliptic orbit, and within the short period of about three years and a third; but its path cuts the orbits of four planets. It approaches within the distance of Mercury, and recedes to about four-fifths of the distance of Jupiter from the sun. The body appears to be without nucleus, or any regularly defined form, and stars are seen through it. These phænomena seem to correspond with the hypothesis of condensed or condensing nebulous matter, suggested by the greatest of sidereal astronomers. And this comet, as it may then be called, attached to our system, and describing equal areas in equal times round the sun, must be considered, in many respects, as the most interesting known body at present in the universe. Your Council have therefore been anxious to mark the high sense they entertain of the ability and persevering industry which must have been exerted in determining all the elements of an orbit so excentric, so much exposed to the influence of several planets, incapable of being estimated by the formulæ adapted to orbits nearly circular, and founded moreover, as these elements must have been, on observations difficult to make, and much limited in point of time, and perhaps affected by the action of a resisting medium.

The other royal medal has been awarded by your Council for a communication made under circumstances the most interesting and most afflictive. An individual of whom not this Society alone, but all England, is justly proud, whose merits have been appreciated and distinguished by each of the eminently scientific establishments of Europe, has recently been assailed by one of the most severe maladies to which human nature is exposed. But the energies of his mind soaring beyond bodily infirmities, he has employed them in a manner (I will presume to say) most acceptable to the Divinity, because most usefully to mankind, by imparting, through the medium of this Society, further stores of knowledge to the world, which has been so frequently before illuminated by the splendour of his genius. On the first day of our meeting, a paper from Dr. Wollaston was read, descriptive of the processes and manipulations by which he has been enabled to supply all men of science with the most important among the recently discovered metals. Platinum, possessed of various qualities useful in an eminent degree to chemists, even on a large

large scale, withheld them all by resisting fusion in the most intense heat of our wind furnaces. Alloyed, indeed, with arsenic, it becomes susceptible of receiving ornamental forms; but a continued heat expels the volatile metal, and leaves the other in a state wholly unfit for use. Dr. Wollaston, instead of alloying, purified the platinum from every admixture by solution, consolidated its precipitate by pressure, by heating, and by percussion, so as to effect a complete welding of the mass, thus made capable of being rolled into leaf, or drawn into wire of a tenacity intermediate between those of iron and gold. To these scientific and beautiful contrivances we owe the use of a material, not only of high importance to refined chemistry, but now actually employed in the largest manufactories for distilling an article of commerce so abundant and so cheap as sulphuric acid. And, above all, we owe to them the material which, in the skilful hands of some members of this Society, has mainly contributed to their producing a new species of glass, which promises to form an epoch in the history of optics. Your Council have therefore deemed themselves bound to express their strong approbation of this interesting Memoir, (independently of all extraneous circumstances,) by awarding a royal medal to its author. And they anticipate with confidence a general approbation, in both these instances, of what they have done.

The Copley Medal for the present year has not been given.

The following is the list of officers for the ensuing year:—

President: Davies Gilbert, Esq. M.P.—*Treasurer:* Captain Henry Kater.—*Secretaries:* Dr. Roget and Captain Sabine, R.A.

Council.—Francis Baily, Esq.; Charles Bell, Esq.; Robert Brown, Esq.; Francis Chantrey, Esq. R.A.; Right Hon. Sir George Cockburn; Michael Faraday, Esq.; Dr. Fitton; Charles Hatchett, Esq.; John F. W. Herschel, Esq. M.A.; Sir Everard Home, Bart.; Captain Kater; Henry, Marquess of Lansdowne; Right Hon. Robert Peel; John Pond, Esq. A.R.; Dr. Roget, Captain Sabine; Rev. Adam Sedgwick; Henry Warburton, Esq. M.P.; Dr. Wollaston; Dr. Young.

LINNÆAN SOCIETY.

Dec. 16.—Read Observations on some species of the Genera *Tetrao* and *Ortyx*, natives of North America, with descriptions of four new species of the former, and two of the latter genus. By David Douglas, F.L.S., &c. &c.

Tetrao.

1. *Tetr. Urophasianus:* Mas. Brunnescenti-griseus, ferrugineo nigroque undulatus, collo anteriore abdomineque imo nigris, pectore albo plumis superioribus rhachidibus rigidis, inferioribus in medio nigro lineatis, plumis colli lateralibus elongatis, linearibus: caudâ cuneatâ rectricibus subrigidis acutâ.

Fœm. Brunnescenti grisea albo nigroque parcè undulata, abdomine imo nigro, pectore albo nigrofasciato, caudâ subcuneatâ, rectricibus subacutis.

T. Urophasianus: C. L. Bonaparte in Zool. Journ. No. 10. p. 212.

Interior of the River Columbia and New California.

 2. *T. Uro-*

2. *T. Urophasianellus:* Mas. Griseo-brunnescens, albo ferrugineo nigroque undulatus, nuchâ alisque albo maculatis, abdomine albo lateribus brunneo fasciatis, rectricibus mediis 4 elongatis.

Fœm. Mari tertio minor, subpallidior, nuchâ nigro fasciatâ, rectricibus subelongatis.

In the same range of country as the preceding species.

3. *T. Sabini* rufus, nigro notatus; dorso maculis cordiformibus, nuchâ alisque lineis ferrugineo-flavis; abdomine albo brunneo fasciato; rectricibus fasciatis, fasciâ subapicali latâ nigrâ.

On the coast of the Pacific Ocean.

4. *T. Franklinii:* Mas. Saturatè plumbeo-griseus nigro fasciatus; gulâ pectore nuchâque nigris, hâc albo graciliter fasciatâ; rectricibus totis nigris, tectricibus supra et infra nigris apice albo.

Fœm. pallidior, gulâ pectore nuchâque plumbeo-griseis.

In the valleys of the Rocky Mountains, and on the N.W. coast.

5. *T. Richardsonii* pallidè plumbeo-griseus fusco sparsim undulatus; gulæ plumis in medio albis; abdomine saturatiore albo parcè maculato; maculâ laterali sub nuchâ albâ; rectricibus nigris apice albicante.

Fœm. Minor brunnescenti-grisea, dorso brunneo fasciata, subtus albo frequenter notata, rectricibus duabus mediis ferrugineo fasciatis.

T. Richardsonii J. Sabine in MSS.

Valleys of the Rocky Mountains, and on the N.W. coast.

ORTYX.

1. *Ortyx picta.* Mas. Fusca subtus ferrugineo-flava nigro fasciata: gulâ rubro-purpureâ albo graciliter cinctâ: pectore vertice caudâque plumbeis: cristâ nigrâ longissimâ, lineari; lineis super cileare albis, caudâ tectricibus inferioribus ferrugineis.

Fœm. Subcristata, gulâ pectoreque fusco-ferrugineis, fusco fasciatis.

Interior of New California.

2. *O. Douglasii.* Plumbeo-brunnea; cristâ erectâ alisque superioribus saturatè brunneis; his flavo-ferrugineo striatis; capite genis nuchâque brunneo et flavo-ferrugineo striatis; gulâ albâ brunneo notatâ; abdomine albo guttato.

O. Douglasii Vigors MSS.

X. *Intelligence and Miscellaneous Articles.*

DECEASE OF DR. WOLLASTON.

WITH regard to the great loss which the scientific world has just sustained by the death of Dr. Wollaston, there can be but one feeling. We trust we may be enabled to dedicate some of our pages to the memory of this eminent philosopher in an early Number.

SCIENTIFIC BOOKS.

To be Published by Subscription, in one volume, 4to, Feb. 1, 1829.

A Description of the Strata of the Yorkshire Coast; with a Section of the Cliffs from Spurn Point to Redcar; a Geological Map of the neighbouring

neighbouring Country; and numerous Plates of the Organic Remains. —By John Phillips, F.G.S., Keeper of the Museum of the Yorkshire Philosophical Society; Hon. Mem. of the Philosophical Societies of Yorkshire, Leeds, and Hull.

Plan of the Work.—Introduction.—Historical view of opinions concerning the Geology of the coast of Yorkshire. Chapter I.—Condensed view of the modern practical system of Geology. The stratification of rocks; their organic contents; the effects produced upon them by the deluge, and other grand operations of nature. Chapter II. —Description of the eastern part of Yorkshire, considered in districts, according to geological and topographical features; comparison of the strata with analogous formations in other parts of England; illustrated by a coloured map. Chapter III.—Particular description of the coast, illustrated by many drawings of interesting junctions of strata, and a large coloured section of the cliffs from Spurn Point to Redcar. In this part of the work, the rocks will be minutely described as to thickness, mineralogical composition, and organic contents; and the heights of the cliffs stated from actual measurement. Chapter IV.—Arranged Catalogues, accompanied by numerous figures, of the organic remains found in the eastern part of Yorkshire, and comparison of them with those which occur in the same strata, in other counties of England. Mr. Smith's law of the regular distribution of organic fossils in the earth will be strictly examined, and applied to determine the relations of the Yorkshire strata to those in various parts of England, Scotland, and the Continent.

To accomplish these objects, the author has, within the last five years, repeatedly examined, measured, and described on the spot, the whole range of the Yorkshire coast; frequently traversed the interior in various directions; examined more than five hundred species of fossils from the eastern part of the county, and represented upwards of four hundred, in drawings principally designed for the present publication. The author deems it necessary to state that his work essentially differs, both in object and plan, from the Geological Survey of the Yorkshire Coast by Messrs. Young and Bird, who have just published a second edition. In the volume now offered to the public, the descriptions and inferences are founded on modern discoveries; the first principles of Geology are methodically discussed; the organic fossils are arranged according to the most approved and established systems of natural history, and employed to discriminate the strata: the whole illustrated by numerous plates, containing several hundred species of fossils never before figured.

York, Nov. 6, 1828.

We observe with pleasure in Mr. Phillips's Subscription-list, the names of the Literary and Philosophical Societies in Yorkshire, and of their Presidents, together with those of Dr. Fitton, Professor Buckland, Dr. Henry, &c.

The Arcana of Science and Art for 1829, will be published early in January, containing all the Popular Discoveries and Improvements of the past year, in Mechanical and Chemical Science, Natural History, Rural and Domestic Economy, the Useful and Fine Arts, and a Miscellaneous Register.

Andrew Ure, M.D. F.R.S. &c. has in the Press a large Octavo Volume, entitled "A New System of Geology, in which the Great Revolutions of the Earth and Animated Nature are Reconciled at once to Modern Science and Sacred History." The Author has undertaken to solve, on the known laws of Physics and Chemistry, the various Enigmas relative to the Temperature of the Antediluvian Globe, and to the Gradation of the Organic Remains of its successive Strata.

This work will be illustrated by Copper-plate Engravings of Shells, characteristic of the Strata and their superposition, of the Bone-Caverns, and of Casts of Fossil Plants; besides about 50 Wood Engravings, representing the most curious Animal Inhabitants of the primæval World described by Cuvier, and other Fossil Zoologists. The Volume will appear about the end of January.

Just published.

A Circular, explanatory of Skene's Patent as applicable to Steam Navigation, and Undershot Water-Mills. London, 8vo. pp. 22. and two lithographs.

This tract contains a list of the agents for the disposal of the right of using Mr. Skene's invention, the specification of the patent, some remarks by the patentee, an account of some experiments with steam-vessels having paddles constructed in the manner proposed, a statement of the saving of fuel by the invention, and a notice of its application to water-mills.

It would be impossible for us to give any correct ideas of the nature of this invention, without reference to plates. Experience alone can prove its merits; but however applicable Mr. Skene's floats may be to the slow motion of undershot water-wheels, we think their successful application to the rapid rotation of the paddle-wheels of a steam-vessel a matter of some doubt.

The Englishman's Almanack; or Daily Calendar of General Information for the Year 1829, comprising, besides the usual contents of an Almanack, the Calendar of Flora, Meteorological and other Tables, &c. &c.

The compilation of this Almanack does much credit to the Editor and to the Stationers' Company, for whom it is printed. The very unfair attack made on them last year on account of some of the almanacks which were still in demand, though in a course of being gradually superseded by the progress of education among the people, induces us to bear our testimony to the merits of those Almanacks and Diaries intended for the well-informed and scientific, which have long been carried on under the direction of the Company.

LECTURES.

Mechanics' Institution:—On the 1st of February 1829, Dr. Joseph Reade, author of "Experimental Outlines for a new Theory of Vision, Light, and Colours," will commence a Course of Lectures on Optics.

Russell Institution:—On Monday, January 12th, 1829, Mr. E. W. Brayley,

Brayley, jun. A.L.S., will begin a popular Course of Lectures on Zoology, devoted principally to the illustration of some of the more generally interesting points of organization in the primary groups of animals. These Lectures will be succeeded, on March 9th, by a Course on Natural Philosophy by Mr. C. F. Partington.

AURORA BOREALIS.

On Monday night, December 1st, an aurora borealis was observed here at intervals from six o'clock till after midnight. It first rose in the N.W. in the form of a segment of a circle cut by that part of the horizon, showed a bright flame-colour about twelve degrees high, and disappeared at half-past six. At seven it again appeared, brightest about the magnetic North, when seven or eight light red coruscations or columns of light rose from it perpendicularly, nearly due North, to an altitude of twenty degrees; and several small meteors fell in that quarter. At a quarter before eight it again disappeared, and reappeared at ten, when several columns of light rose from its base, and it continued more or less bright till after midnight.

Its disappearing as above stated, may be attributed to the effect of an upper current of wind from the S.W., as ascertained by the motion of black clouds from that quarter. A very hard gale blew next the earth from the N.E. through the evening and night, with a sudden rise of the mercury in the barometer.

LIST OF NEW PATENTS.

To W. Godfrey Kneller, of Great Pearl-street, Spitalfields, chemist, for improvements in evaporating sugar, applicable also to other purposes.—Dated the 27th of November, 1828.—6 months allowed to enroll specification.

To Joseph D'Arcy, of Leicester-square, esquire, for certain improvements in the construction of steam-engines and the apparatus connected therewith.—29th of November.—18 months.

To E. D. Philp, of Regent-street, chemist, for an improved distilling and rectifying apparatus.—29th of November.—6 months.

To R. Stein, of Regent-street, for improvements in distillation.—4th of December.—6 months.

To W. Brunton, of Leadenhall-street, for an instrument to ascertain and register the quantity of specific gravity and temperature of certain fluids in transit, part of which invention is applicable to other purposes.—4th of December.—6 months.

To P. Derbishire, of Ely Place, Holborn, for a certain medicine or embrocation to prevent or alleviate sea-sickness, which may be usefully applied to other maladies.—4th of December.—6 months.

To Z. Riley, of Union-street, Southwark, engineer, for certain improved apparatus to be attached to carriages for safety in travelling.—10th of December.—4 months.

To G. Rennoldson, of South Shields, for his improvements in rotatory steam-engines, &c.—4th of December.—6 months.

To

To J. Hague, of Cable-street, Wellclose-square, engineer, for improvements in the method of expelling the molasses or syrup from sugar.—6th of December.—2 months.

To I. Dickson, of Chester-street, Grosvenor Place, for an improved projectile.—8th of December.—2 months.

To J. Boase, of Albany-street, gentleman, and T. Smith, mechanic, of Augustus-street, both in Regent's Park, for their improvements in machinery for scraping, sweeping, cleaning, and watering streets and roads.—10th of December.—2 months.

To T. Lawes, of the Strand, for his improvement in the manufacture of bobbin-net lace.—10th of December.—6 months.

To C. Cummerow, of Lawrence, Pountney-lane, for certain improvements, communicated from abroad, in propelling vessels.—10th of December.—6 months.

To A. Louis, of Dean-street, Birmingham, mechanic, for a mechanical *Volti subito*, to assist the player of music quickly to turn the leaves of music-books whilst playing.—10th of December.—2 months.

METEOROLOGICAL OBSERVATIONS FOR NOVEMBER 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·26 Nov. 1. Wind W.—Min. 29·23 Nov. 16. Wind S.W.
Range of the index 1·03.

Mean barometrical pressure for the month	29·856
Spaces described by the rising and falling of the mercury.....	4·220

Greatest variation in 24 hours 0·430.—Number of changes 18.
Therm. Max. 60° Nov. 21 & 28. Wind S.W.—Min. 29° Nov. 11. Wind N.
Range 31°.—Mean temp. of exter. air 49°·52. For 30 days with ☉ in ♏ 48·53
Max. var. in 24 hours 21°·00—Mean temp. of spring water at 8 A.M. 55°·38

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the morning of the 16th.....	94°
Greatest dryness of the air in the afternoon of the 1st	57
Range of the index.....	37
Mean at 2 P.M. 68°·4 —Mean at 8 A.M. 77°·2—Mean at 8 P.M.	78·1
—— of three observations each day at 8, 2, and 8 o'clock.....	74·5

Evaporation for the month 1·05 inches.
Rain near ground 1·875 inches.

Summary of the Weather.

A clear sky, 1½; fine, with various modifications of clouds, 13; an overcast sky without rain, 11; foggy, 1; rain, 3½.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
20	13	30	2	12	13	12

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2	2½	4	5	3	6½	5½	1½	30

General Observations. — This has been a pleasant month, and was generally mild and dry for the season: but the 8th, 9th, 10th, 11th and 12th were very cold days, with frosty nights, which were brought on by the

the induction of a piercing gale from the East. This change was so sudden, as to cause a difference of eighteen degrees in the maximum temperature of the external air between the 7th and 8th.

On the 8th the thermometer only rose to 38 degrees; but on the 21st and 28th it rose to 60 degrees. The difference in the minimum temperature of the nights of the 11th and 27th is still greater.

The sudden disleafing of the trees after the frosts and two or three heavy dews was very remarkable; the moral of which has been generally applied to November by the poet, thus:

> " Nocturnal dews, caused by the absent sun,
> And hoary frosts have sometime since begun
> To shower down the fading leaves, which lie
> Upon recipient earth, and quickly die—
> An emblem of the finite end of man."

The mean temperature of the external air this month is 2¼ degrees higher than the mean of November for many years past. If there be any *truth* in the supposition of some writers on Cometary Astronomy, that the humid atmospheres of comets extend to, in the course of their revolution, and purify the noxious gases in the atmospheres of the planets; and also promote in them an additional heat on approaching their perihelion,—the uncommon mildness of the air since the 12th instant, in a great measure verifies it, by the presence of Encke's comet.

The atmospheric and meteoric phænomena that have come within our observations this month, are two parhelia, two solar and five lunar halos, seventeen meteors, one rainbow; and seven gales of wind; namely, two from the East, one from the South-east, one from the South, and three from the South-west.

REMARKS.

London.—November 1. Cloudy. 2. Very fine. 3. Foggy in the morning and at night: fine. 4. Thick fog in morning: very fine. 5. Cloudy: foggy at night. 6. Fine morning: cloudy. 7. Cold and cloudy. 8. Cold and cloudy: stormy at night. 9. Fine. 10. Slight fog in morning: cloudy. 11. Dense fog all day. 12. Dense fog, so much so at night that the mails were upwards of an hour behind their usual time of passing through Turnham Green, and were obliged to be conducted by torches. 13. Foggy morning: fine. 14. Rainy. 15. Cloudy,with showers. 16. Rainy. 17. Cloudy morning: fine. 18—20. Fine. 21. Very fine. 22. Cloudy. 23—25. Slight fog in mornings: fine. 26. Drizzly: stormy and wet at night. 27. Fine morning: cloudy. 28. Very fine. 29. Cloudy morning: fine. 30. Fine.

Penzance. — Nov. 1. Fair: clear. 2—5. Fair. 6, 7. Rain. 8. Rain: fair. 9—11. Clear. 12, 13. Showers. 14. Showers: heavy gale. 16. Showers. 17. Fair. 18. Fair: rain. 19. Clear: fair. 20, 21. Fair. 22. Misty. 23. Clear. 24. Fair: showers. 25. Misty. 26. Rain. 27, 28. Clear. 29. Misty. 30. Fair.

Boston.—Nov. 1, 2. Cloudy. 3—5. Fine. 6. Cloudy. 7. Fine. 8. Stormy. 9. Rain. 10, 11. Foggy. 12, 13. Fine. 14—17. Cloudy. 18. Fine. 19, 20. Cloudy. 21. Fine. 22. Cloudy. 23—25. Fine. 26. Cloudy. 27—29. Fine. 30. Cloudy.

Meteorological Observations made by Mr. BOOTH at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
Nov. 1	30·311	30·251	30·30	30·28	30·26	30·21	29·21	58	44	54	44	56	47	48	W.	NW.	NW.	calm	...	...	...	...	...
2	30·285	30·249	30·26	30·22	30·25	30·22	29·72	54	41	54	48	56	47	46	SE.	NW.	N.	calm	...	...	...	...	...
3	30·374	30·326	30·20	30·15	30·26	30·24	29·90	57	37	53	48	59	48	44	E.	S.	E.	calm	0·10	...	...	0·010	...
4	30·250	30·214	30·05	30·00	30·17	30·13	29·75	56	34	54	50	55	48	49	SE.	S.	SE.	calm	...	...	...	...	...
5	30·196	30·153	29·95	29·94	30·09	30·09	29·73	53	34	55	50	56	48	45·5	SE.	S.	SE.	calm	...	...	...	...	...
6	30·138	30·108	29·88	29·80	30·04	30·03	29·71	50	42	58	52	58	48	44	E.	SW.	SE.	E.	·15	...	...	·060	...
● 7	30·160	29·971	29·75	29·65	29·94	29·80	29·65	48	35	56	52	56	35	48	E.	SE.	E.	E.	...	...	0·240	...	...
8	29·923	29·853	29·56	29·56	29·79	29·74	29·70	40	28	50	50	38	32	36·5	NE.	SE.	NE.	NE.	...	...	·980	...	...
9	29·839	29·655	29·56	29·55	29·68	29·59	29·44	48	31	45	45	40	36	37	NE.	NE.	NE.	calm	·20	...	...	...	...
10	29·564	29·477	29·55	29·54	29·47	29·40	29·20	40	26	45	40	45	32	36·5	NE.	NE.	NE.	calm	...	...	...	...	...
11	29·641	29·597	29·60	29·55	29·57	29·50	29·22	36	21	50	44	42	29	26·5	S.	NW.	N.	calm	...	...	...	...	...
12	29·699	29·647	29·60	29·55	29·62	29·56	29·33	37	29	53	44	47	40	30	SE.	W.	E.	calm	·10	...	·360	·370	...
13	29·729	29·707	29·55	29·50	29·63	29·62	29·30	56	38	55	47	56	49	38	S.	SW.	S.	S.	...	...	·200	...	...
☽ 14	29·539	29·340	29·20	28·95	29·44	29·28	29·21	55	45	56	52	54	50	43·5	SE.	SE.	SE.	calm	...	·22	·075	·450	...
15	29·400	29·372	29·14	29·12	29·33	29·31	29·00	55	48	54	52	58	51	46·5	SW.	SW.	SE.	calm	·10	·10	·280	·525	0·23
16	29·438	29·241	29·50	29·35	29·40	29·23	28·93	53	45	55	50	56	43	50	SW.	NW.	SW.	S.	...	·27	·440	·120	·25
17	29·821	29·478	29·85	29·75	29·78	29·64	29·20	52	35	52	45	53	43	46·5	W.	NW.	W.	NW.	...	...	·045	...	·13
18	30·033	29·966	29·98	29·95	29·99	29·90	29·42	51	33	52	42	50	42	40	NW.	NW.	W.	NW.	·10	·15	...	·070	...
19	30·214	30·011	30·20	30·15	30·20	30·00	29·51	52	40	54	45	52	45	42·5	NW.	NW.	W.	N.	...	...	·245	...	·29
20	30·216	30·063	30·18	30·10	30·14	30·04	29·60	54	47	55	48	55	51	51	W.	SW.	W.	NW.	...	...	...	...	...
○ 21	29·983	29·912	29·95	29·90	29·97	29·88	29·43	59	48	55	50	60	49	48	W.	SW.	SW.	W.	·10	...	...	...	...
22	29·972	29·924	29·84	29·80	29·93	29·82	29·27	55	30	52	48	59	40	51	NW.	W.	SW.	NW.	...	·03	...	·005	...
23	30·024	29·846	29·95	29·65	29·91	29·80	29·58	53	42	54	44	55	47	37·5	SW.	SW.	E.	calm	...	...	...	·005	·15
24	29·813	29·716	29·55	29·45	29·75	29·67	29·33	54	36	56	50	56	47	45	S.	S.	SE.	N.	·05	...	...	...	...
25	29·946	29·811	29·85	29·84	29·90	29·87	29·42	56	43	57	50	57	52	45	S.	SW.	S.	NW.	...	...	·140	...	...
26	29·904	29·805	29·85	29·85	29·88	29·80	29·30	57	45	54	51	59	47	53	NW.	SW.	SW.	NW.	...	·24	·830	·230	...
27	30·113	30·011	30·07	30·05	30·09	29·98	29·42	57	48	55	48	54	53	47·5	W.	W.	W.	NW.	·05	...	...	·020	·18
28	30·125	30·101	30·15	30·15	30·12	30·09	29·46	60	50	58	52	60	52	55	W.	W.	SW.	calm	...	...	...	...	...
☾ 29	30·151	30·123	30·18	30·15	30·12	30·10	29·43	59	46	55	52	58	52	55	NW.	W.	SW.	W.	...	·11	...	...	...
30	30·139	30·013	30·15	30·10	30·10	30·00	29·64	55	42	54	47	58	50	50	NW.	W.	W.	calm	·10	...	...	·010	·08
Aver.:	30·374	29·241	30·30	28·95	30·26	29·23	29·43	60	21	58	40	60	29	44·5					1·05	1·12	3·835	1·875	1·31

UPPER CANADA

UPPER CANADA

Shallow Lakes

LAKE SIMCOE

Kempenfelt Bay

Darlings I.

Graves I.

R. Nottawasaga

Chebuttoquon

SIMCOE

DURHAM

NORTHUMBERLAND

HASTINGS

R. Trent

Otonabec

Rice L.

Alnwick

Percy

Marmora Crowe L.

Iron Works

Ramdon

Huntingdon

Hungerford

Sidney

Mohawks

Sheffield

LENOX & ADDINGTON

Camden

R. Napanee

Hinchinbroke

FRONTENAC

Pittsburgh

Kingston

Bedford

Crosby

Bastard

Leeds

Lands-down

Yonge

Lake of the Thousand Isles

Brockville

Prescot

Ogdensburg

Black L.

JEFFERSON

Oswegatchi Riv.

Forests partially cleared

MOUNTAINS

MACOMB'S

YORK

WEST RIDING

MISSISAGA TRACT

Scott

Robinsons Mill

Whitchurch

King

Vaughan

Markham

Pickering

EAST

Whitby

Darlington

Clarke

Hope

pt. Hope

Hamilton

Haldimand

Cramahe

Murray

Prince Edward

Amelia sb.

Sophiasburg

Ameliasb.

Bay of Quinte

Mary's bg

Newcastle

Resquisle

Nicholas I.

St. Peter's Bay

Amherst I.

Simcoe

Wolfe I.

Carleton

Kingston Ferry

Chaumont

ONTARIO Cape Vincent

False Ducks

Duck Is.

Pt. Traverse

Hungry B.

Stoney B.

Henderson

Brownville

Sackets Harbour

Watertown

Beaver Ck.

Ellisburg

Salmon R.

Fort Oswego

Onondaga R.

ONEIDA

Fish Ck.

Leyden

Black River

Rottesdau

Lake Oneida

Rome

Trenton

Canada Ck.

Liverpool

Salina

Oneida

Onondago

Manlius

Cazenovia

Utica

Mohawk R.

Herkimer

Little Falls

German Flats

ONONDAGA

Seneca R.

Palmyra

Mud Creek

Canandaigua R.

Batavia

Allen's C.

Southampton

Genesee

L. Conesus

Hemlock L.

Honeoye L.

Canandaigua Lake

Geneva

Seneca L.

Crooked Lake

Cayuga Lake

Owasco L.

Skeneateles L.

Ostisco L.

CAYUGA

GENESSEE

Lockport

Tonnewanta Ck.

Salt-Spring

Rochester

Carthage

Rundusur Bay

Braddocks Bay

G. Sodus Bay

Fishing Bay

Oak Orchard Ck.

Salt-Spring

R. Genesee

R. Catarraugus

Cohocton R.

Conisteo R.

Chenunio Riv.

R. Unadilla

Cincinnatus

Lake Ontario

Burlington Bay

R. Credit

Trafalgar

Toronto

Gibraltar Pt.

Salmon Fishery

Highlands of York

Ruby Hd.

C. Alured

Little Bay

Salmon Fishery

10 Mile Ck.

12 Mile Ck.

C. Paradise

Beverley

East Flamboro

West Flamboro

Nelson

Dundas

Ancaster

Binbrook

Glanford

Grimsby

Louth

Newark

Niagara

R. Niagara

Fishing Bay

Salt-Spring

Oak Orchard Ck.

Braddocks Bay

R. Genesee

Rundusur Bay

G. Sodus Bay

Fort Oswego

Onondaga R.

Salmon R.

HALDIMAND

NIAGARA

LINCOLN

Caistor

Gainsboro

Pelham

Queens

Falls

Chippawa

Grand

Marsh

Wainfleet

Humberstone

Bertie

F. Erie

Buffalo

Buffalo Ck.

Elliotts Ck.

Sulphur Spring Ck.

Batavia

Mouth or Grand R.

R. Ouse or Grand R.

L. ERIE

R. Niagara

Sturgeon Pt.

S. Porter

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

FEBRUARY 1829.

XI. *A Sketch of the Topography and Geology of Lake Ontario.* By J. J. Bigsby, *M.D. F.L. and G.S., For. Mem. Amer. Phil. Soc. &c.*

[With a Map.]

[Continued from p. 15.]

Topography of the Outlet of Lake Ontario, including the Lake of the Thousand Islands.

THE outlet of Lake Ontario, known as the River St. Lawrence, Iroquois or Cataraqui, is placed at the north-east end of the lake, and runs N.E. as far as Montreal (202 miles); with the exception of the small portion by the township of Cornwall, at the head of Lake St. Francis, and of the forty miles above Montreal; in both cases the change being to the E.N.E. At present we are only concerned with the gorge of the lake, the upper fifty-eight miles of the St. Lawrence, included between the towns of Kingston and Brockville, a space distinguished from that below by very marked features; as its breadth, the form of its shores, the number of its islands, and its being chiefly occupied by primitive rocks.

Of the country surrounding the outlet I am only personally acquainted with that on the Canadian shore. I am informed, and I partly know, that there is little difference on either side. The districts on the north are rendered rugged, unsightly, and comparatively unproductive by the great prevalence of naked or ill-clad ridges of rock; they are usually only from twenty to forty feet high, and very seldom rise into hills, unless it be in the interior; as about the Loughborough chain of lakes, and at the sources of the Gananoque river. These ridges vary from the state of complete ruin, in large angular blocks, to that of round-backed and glazed mounds;—in most cases elongated in a north-east direction. They are commonly placed near

merous in the space of sixteen miles included between a point two miles and a half below Gananoque, and another, twenty-two miles above Brockville. The interval appropriately named "the Lake of the Thousand Islands," extends from Gananoque to within thirteen miles of Brockville. Its scenery has been depicted by Howison in his Sketches of Upper Canada a good deal too floridly, and in a way calculated to disappoint its visitors. It must, however, be admitted, that all that can be effected by ever changing combinations of isle and mainland moderately high, of rocks, woods and waters, unrelieved by hills in the distance, is done in a manner singularly beautiful.

The first fourteen miles from Kingston are almost wholly occupied by two very large islands, Long, Grand, or Wolfe, and Howe or Sir John Johnstone's Islands.

Grand Island, containing 31,283 acres*, is $17\frac{3}{4}$ miles long in a north-east direction, and has its upper end (called Long Point) $5\frac{1}{2}$ miles above Kingston. It is an irregular oblong, broad in its upper half ($6\frac{2}{3}$ miles wide at Kingston), and has a mean breadth of about a mile below Carleton Bay, a deep swampy indenture near the middle. Its point of nearest approach to the north main is 3 miles below Point Henry, and is a mile distant. That on the south main being $\frac{3}{4}$ of a mile, and situated a mile and two-thirds below Long Point above spoken of. The nearest part of the island is two miles distant from Kingston. It has been awarded to the British, to whom, in fact, it is indispensably necessary for the protection of their naval and military establishments on Lake Ontario. Its interior is nearly in a state of nature. It is fertile, level, low, and often swampy.

Howe Island, fertile and undulatory, is $8\frac{2}{3}$ miles long, with an average width of $1\frac{2}{3}$ mile. It is separated from the north main by a channel of pretty uniform breadth, which sometimes is only $\frac{1}{4}$ of a mile. It is nearest Grand Island (with which it runs more or less parallel) at the upper end, and is there $\frac{2}{3}$ of a mile from it. The head of Howe Island is $5\frac{1}{2}$ miles below Fort Henry.

These two islands have but few others around them. Of these the largest are Simcoe Island, at the head, and on the north of Grand Island, and Carleton Island on its south, opposite to the bay of that name. Simcoe Island is $3\frac{2}{3}$ miles long and a mile and a third in greatest breadth. Carleton Island is $2\frac{1}{2}$ miles long, with a mean breadth of two-thirds of a mile.

Proceeding now below Grand Island, the next of great size, is the compact "Grindstone" Island, $5\frac{2}{3}$ miles long by a mean

* According to Messrs. Thompson and Bird, astronomers.

width

width of a mile and three quarters. It is $2\frac{3}{4}$ miles from the north main, and 1 mile from the south, opposite Gananoque. It contains 5,316 acres (as stated by Messrs. T. and B.) and belongs to the United States.

"Wells" Island, consisting of 7950 acres, is $1\frac{1}{7}$ mile below Grindstone Island, and is better described as two oblong and parallel islands joined near their top by an isthmus. The larger portion (running N. E.) is 8 miles long and 3 in greatest breadth; while the smaller is $4\frac{1}{2}$ miles long and $\frac{2}{3}$ds of a mile in average breadth. The channel between this island and the south main is always very narrow, and in one place only two hundred yards across. It belongs to the United States, being always more than a mile from the north main.

Club Island (British) is $3\frac{1}{3}$ miles long and one mile in greatest breadth, tapering at each end; in its upper third it lies close to the smaller division of Wells Island, the interval being often only thirty to forty yards, and containing also many islets. It is five hundred yards from the Canadian shore at its lower end.

Wells and Club Islands are in the heart of the Lake of the Thousand Isles, and are accordingly surrounded with multitudes of islands, large and small, very many being mere patches of rock. They universally run N.E. or nearly so, and are commonly narrow, with their sides steep or precipitous, and their extremities dipping gently into deep and clear waters. They are from twenty to a hundred feet high, and are for the most part well wooded with cedar, hemlock, pine, &c., but frequently again are bare bleached rocks, smooth, glazed, or in large square fragments.

The next island of considerable size is some distance below "Wells." It is called "Tar Island," and is nearly two miles long by a mean breadth of $\frac{1}{4}$ of a mile. It is separated from the north main by a rushy shallow sixty yards broad. A few hundred yards S.E. of the head of Tar Island is Yeo's or Bald Rock Island, whereon is a great deposit of schorl.

Grenadier Island is $4\frac{1}{2}$ miles long, its upper third ranging parallel to Tar Island, and in one place only four hundred yards distant. Opposite Smith's tavern on Tar Island it is $\frac{2}{3}$ of a mile from the north main, and is never less than a mile and a half from the south main. The breadth of Grenadier island is very irregular, but may be taken at six hundred yards as a mean. About two miles from its head it is nearly severed by two inlets from the opposite sides; the intervening isthmus being only eighty to a hundred yards broad. This island is elongated in a north-east direction, and contains 1070 acres; most of it under cultivation. It has been awarded to the British.

Indian

Indian Hut Island, the only one remaining which requires distinct notice, guards the mouth of Goose Creek Bay. It is rocky, a mile and two thirds long, and from six hundred to seven hundred yards in average breadth. It is 360 yards from the eastern outer angle of the bay. It belongs to the United States.

The Geology of Lake Ontario.

The situations where the loose transported matters covering the fixed rocks of Lake Ontario particularly abound, have been noticed in the topographical part of this paper, and the inferences they lead to have been stated in the general view of the detritus of Canada, read before the Geological Society of London in the winter of 1826–7.

While the parallel ridge west and south of the lake is composed almost wholly of rock, the eminences bordering this body of water on the north-west are formed of these later deposits, which also overspread in great thickness the interval of thirty-seven miles between Lakes Ontario and Simcoe, and near the latter of which are penetrated for two hundred feet by the River Holland at Robinson's Mills. At that place, a hard well-cemented conglomerate of small primitive pebbles is now forming near the water level. It was altogether out of my power to make any very accurate observations on the nature and position of the component parts of the highlands of York and their vicinity alluded to above. I landed at the highest part of the cliffs six miles east of York, and found the castellated masses there to be of brown marl, effervescing smartly on exposure to acids, tolerably firm in its texture, and full of very small fragments of black limestone. But in the greater part of these heights, the lower half or thereabouts is occupied by a dark blue substance, either a clay or marl, and a yellow material which I take to be sand. This is particularly striking in the second bay from the east. In several places along-shore, about the middle of this line of precipices the beds of sand and clay seem to alternate. There is here so large an accumulation of diluvium, and it is so freely exposed by numerous and deep ravines, that it must be a very favourable spot for the discovery of animal remains: some of which indeed have been discovered in Lake Erie.

Boulders, numerous and of great size, abound everywhere. They are chiefly primitive, and can be referred to their parent-rock in many cases, as in the instance of the milky quartz near Kingston, which extends in rolled fragments even to Lake Erie, having ascended the heights of Queenston. The remarkable augitic trap of Montreal is found in the Genesee Country;

Country; the primitive marble of Crow Lake and the Ottawa is plentiful on the north main of Ontario: the ophicalcic rocks, and tabular spar in large masses of Gananoque and the river just mentioned, are occasionally met with. Where the blocks of glassy tremolite occurring near Bellville come from, I know not. The tabular spar I found at this place, and a few miles east of Grimsby near the head of the lake. The ophicalcic boulder several tons in weight is on the beach in front of the town of York, a few yards from a minutely blended mass, weighing about two tons, of petalite, glassy actinolite, tremolite, quartz, calcspar, and a little copper-pyrites.

The first two of these substances only require remark. They have been described by Dr. Troost* in the following words: The petalite "occurs in crystalline masses of a grayish white colour, with a tinge of green. It has a confused lamellar texture: the laminæ offer in some directions a radiated texture, not unlike some varieties of tremolite, approaching even to fibrous, as observed in the asbestiform actinolite; the fibres are diverging; the laminæ are sometimes scaly and undulated. The cleavage approaches to a rhomboidal prism of 130°, which has again a diagonal cleavage. It breaks with difficulty, offering a rough lamellar and fibrous fracture; the fragments are angular with a glistening lustre, and in the direction of the laminæ somewhat pearly, more or less brilliant. It is strongly translucent on the edges, and strikes fire freely with steel; nearly of the same hardness with feldspar. Its specific gravity is 2·593. It melts with difficulty into an opaque white porous enamel; with borax, it gives a transparent glass. I fused a small quantity of the mineral with potash, dissolved the product in muriatic acid, and then evaporated it to dryness, and digested the mass in alcohol, by which it was partly dissolved and formed a solution which burned with a red flame, of a more dense colour than that of strontian. The quantity which I subjected to analysis was too small to enable me to ascertain the quantity of the lithia, and the proportion of the other ingredients. The actinolite which covers the petalite is very handsome: it seems to be a vein in which the crystals of actinolite of a fine green colour are cemented together by lamellar carbonate of lime. The crystals are nearly transparent, almost cylindrical, with the exception of a few which belong to the bis-unitaire, and the tri-unitaire of Haüy; the same form as those which are found at Franklin, New Jersey."

[To be continued.]

* Journal Acad. of Sciences, Philadelphia, vol. iii. p. 235.

XII. *On*

XII. *On the Natural Zero, according to Fahrenheit's Scale.* By Sir George Cayley, *Bart.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

3, Rue Castiglione, Paris, Dec. 20, 1828.

I SEND you the following considerations respecting the natural zero, which though perhaps not perfectly conclusive, yet lead to a strong probability that the point of absolute privation of transferable caloric, as respects temperature, takes place at 448 degrees of Fahrenheit's scale below his 0°, taking such degrees of this scale as range between 32° and 212° as the standard, and leaving the more refined inquiry as to their inequality at present out of the question, though fully admitting that the zero I have named must hereafter be regulated by the final result of that inquiry.

It appears that hydrogen gas at a mean temperature is about 11,242 times lighter than water, and also that it can exist as a component part of water: hence if it were mechanically condensed 448 times, when of the temperature of 32°, and supposing the particles to be as dense as water, there would still remain twenty-two-fold more space unoccupied than occupied by them; hence there would be no reason to suspect that their chemical relation to each other would be altered or deranged by this condensation. If 10,000 cubic inches of hydrogen gas under mean atmospheric pressure at a temperature of 32°, be elevated to the temperature of 212°, it will be expanded to 13,744 cubic inches, and all the experiments that have been made on the subject prove, that the expansion or contraction of all the gases at a temperature of 32° proceed in perfect uniformity with the addition or privation of caloric as measured by the thermometer, giving one 480th part of the whole bulk for each degree of Fahrenheit's scale. As this is the property of *all* the permanent gases, differing so widely as they do in their specific gravities, chemical qualities, and in their specific relation even to caloric itself, it seems to point out that in these aëriform fluids, when chemical attraction is in their own nature overcome, the expansion becomes the actual measure of the transferable caloric they contain, in that relation to heat we call temperature. In all these gases if we could reduce the temperature 480° below 32°, all bulk, as connected with temperature, would cease; the particles would become contiguous, and deprived of all elasticity. The effect seems the measure of the cause; they originate and cease together. It may be argued against this theory, that steam and the vapours

of

of different fluids, as those of æther, alcohol, &c. are found to expand with equal uniformity by equal additions of temperature; but that each vapour has its own grade of elasticity: and hence that privation of caloric at which elasticity would cease, differs in each; chemical affinity between the particles in these cases seems to exert to a certain extent a controlling power over caloric, and to modify its action. There is also a chemical combination of caloric with these fluid substances when they change to a state of vapour, which may materially affect their relation to transferable caloric: thus steam of 212° contains about 960° degrees of caloric in chemical union, which does not affect its temperature. It depends upon the degree of pressure the water is exposed to, at what temperature it will rise into vapour and commence this vast but imperceptible absorption of caloric. An additional pressure of three pounds per square inch, requiring about ten degrees more temperature before vaporization commences; hence the power, whatever it be, by which the caloric enters into chemical union at 202°, is three pounds per square inch less forcible than at 212°, and six pounds less than at 222°, the whole power at 212° being equal to about fifteen pounds per square inch. The same ratio exists as to this power in alcohol at 176°, and in æther at about 98°; in the former 38 degrees below the boiling point of water, and in the latter 128°. The expansive power arising from temperature in these cases is evidently modified by the chemical affinities of these substances, as is rendered more evident by the circumstance that æther, the boiling point of which is so much below that of alcohol, freezes at −46°; whereas alcohol has been exposed to a temperature of −91° without freezing; and it rests on one authority only that it can be congealed at all, and that at a temperature of −110°. The striking circumstance with respect to the permanent gases is, that they all agree as to the privation of temperature at which they would cease to be elastic. In their chemical formation they seem to have embodied permanently as much caloric as neutralizes all attraction between their particles; and hence every addition of temperature from the natural zero exhibits an expansion, or a force equivalent, if unrestrained, to generate expansion.

When we see that a few pounds pressure per square inch has so much effect upon fluids when upon the point of rising into vapour, and contemplate the power which the particles of water exert when passing into the state of ice, so as even to split bomb-shells and cannon,—it seems very probable that in vapours, the effects of temperature are disturbed by counteracting forces, but that they have their full and undisturbed in-

fluence with perfect uniformity in the gases; and that all these point to 480° below 32°, or 448° below 0°, as their temperature of non-elasticity or privation of all transferable caloric. There is an apparent contradiction to this hypothesis in the circumstance that common air, when suddenly condensed seventy or eighty times, kindles the tinder called amadou, and fires gunpowder, &c.; but as the *capacity* of bodies for caloric is in some inverse ratio of their density, much heat must be evolved by such a great increase of density; even a red heat is soon excited, by the condensation of soft iron under the hammer to the extent of only 1-33rd part of its bulk; and hence the fact is sufficiently accounted for, and is a case quite distinct from the caloric of temperature.

For the purpose of showing how small a proportion there is between the 448 degrees I have assumed as beyond the zero of Fahrenheit, and the absolute quantity of caloric embodied by some of the permanent gases, let two volumes of hydrogen gas be condensed 448 times when of the temperature of 0° Fahr.; and as this is the proper proportion to generate water by combustion, supposing the particles to be each of the density of water, they would not be reduced to contact by this degree of condensation, but would have about sixteen times more space unoccupied than occupied: hence their chemical constitution would not be endangered unless done too suddenly, so as to evolve caloric enough to ignite them. If this mixture were reduced to the temperature of 448° below 0°, the particles would then be in contact, and require no pressure to keep them so. We may probably assume without much error, that from the reduced capacity as to caloric, as much of it will have escaped, from this cause, as would raise the temperature of the condensed mass about 900 or 1000 degrees, and at the same time it will have lost by temperature 448°: thus it might be said that 1448 degrees of heat are parted with by the gases before they reach the natural zero; but it is obvious that the 448° only are due to the account of *thermometrical temperature;* the other to a separate and distinct cause; viz. the diminution of capacity with respect to the caloric permanently embodied in these gases by chemical combination. I shall quote from some experiments by Count Rumford, on the caloric generated by combustion, that one pound of hydrogen gas used as fuel will raise 410 pounds of water from 32° to 212°, or 180°; (this estimate may not perhaps be very correct, but is sufficient for my purpose) one pound of hydrogen gas requires eight pounds of oxygen gas to saturate it in the formation of steam or water by combustion; and hence the whole caloric, which in the other instance was applied to 410 pounds of water, is during the combustion

combustion applied to the nine pounds of steam or water generated; and therefore its temperature considered as water, would be raised as much more than 180° as 410 exceeds 9 ($\frac{410}{9} \times 180$), or 8200 of Fahrenheit's scale. If we knew with more accuracy the proportionate capacities of water and of these gases, we might thus tolerably ascertain the actual ratio between that caloric which is chemically combined and which seems to constitute the gaseous state, that which is lost by temperature, and that which is lost by reduced capacity. If we assume that, when these two gases are reduced to the contact of particles by a temperature of −448, they have the same capacity for caloric as water, and that in the condensation they have lost 1000 degrees by reduced capacity, we shall have the proportion of that which is moveable by both causes, when compared with that chemically combined and permanent, as 1448 to 8200, or nearly as 1 to 5·7. It is of great importance to ascertain the actual commencement of our scale of temperature, as it would lead to an accurate knowledge of what certain determinate quantities of caloric can effect, and it would come measureable, as the other constituents of compound bodies are. It is very probable that caloric will be found to combine in distinct doses when it enters into those chemical unions not affecting temperature. If we assume −448 as the true zero, and assume 20° as a dose of caloric, the history of water in its relation to it would stand thus: We should have twenty-four doses or 480° of heat in ice at 32°; an addition of seven doses, or 140°, melts it to water; nine doses, or 180°, brings it to the boiling point under atmospheric pressure, and forty-eight doses more, or 960°, generates steam at 212°.

I am, Gentlemen, yours, &c.

Geo. Cayley.

XIII. *On Interpolation.*

(*From* Prof. Encke's *Astronom. Jahrbuch for* 1830, *p.* 265.)

[Concluded from p. 36.]

FOR calculation it is most convenient to correct successively each of the *difference-quantities* by the following one, and separating the common factors to write the formula as follows:

$$(\mathrm{VI}) \qquad X = A + (x-a)\{[ab] + x-b\{[a_1ab] + x-a_1\{[a_1abb_1]\ldots\}\}\}$$

The factors are here used in the following order:

$$(x-b_n),\ (x-a_n),\ (x-b_{n-1}),\ x-a_{n-1}\cdots(x-a_1),\ (x-b),(x-a).$$

If we proceed, therefore, from x, and then first take the

nearest term in order to form $x-a$, and then on the other side $(x-b)$, and continue thus taking differences alternately on one and the other side, the order of the factors is then entirely to be reversed for the use of the formula (VI).

These latter formulæ have this important advantage, that in them no regard need be had to signs, if the following rule is attended to:—that all the *difference-quantities* must be so corrected as to be brought nearer to the above-mentioned line, above and below which they alternately lie, or that the correction must approximate every one to the *difference-quantity* on the opposite side of the line. In order to perceive the reason of this, let the two cases in which the factor of correction is of the form $x-a_n$, and in which it is of the form $x-b_n$, be distinguished. In the former the correction is always

$$+(x-a_n)\,[a_n\,a_{n-1}\,\ldots\,a\,b\,\ldots\,b_{n-1}\,b_n]$$

For brevity let us assume the particular case of $n=1$, and making the proper arrangement of the quantities it will be found that the rule requires, that $[a_1\,a\,b]+(x-a_1)\,[a_1\,a\,b\,b_1]$ should always be between $[a\,b\,b_1]$ and $[a_1\,a\,b]$. But we have by what was shown above $[a_1\,a\,b\,b_1]=\frac{[a\,b\,b_1]-[a_1\,a\,b]}{b_1-a_1}$; consequently the expression (C) becomes

$$=a_1\,a\,b+\frac{x-a_1}{b_1-a_1}\left\{[a\,b\,b_1]-[a_1\,a\,b]\right\}$$

and the factor $\frac{x-a_1}{b_1-a_1}$ is in all cases, by the notation adopted, positive and less than 1. As the quantity $[a\,b\,b_1]$ may be thus expressed $[a_1\,a\,b]+\{[a\,b\,b_1]-[a_1\,a\,b]\}$, it is clear that the correction tends, agreeably to the rule, to approximate the quantity $[a_1\,a\,b]$ to $[a\,b\,b_1]$, with the exception of the single case in which a former correction had changed the sign of the quantity $[a_1\,a\,b\,b_1]$. In this single case of exception there will be a further removal from that quantity. But with some little attention, especially in performing several interpolations, it will not be possible to make a mistake on this head.

The same will take place in the second case, in which the factor of correction is of the form $x-b_n$. The correction is

$$(x-b_n)\,[a_{n+1}\,a_n\,\ldots\,a\,b\,\ldots\,b_n$$

to be applied to $[a_n\,\ldots\,a\,b\,\ldots\,b_n]$, which according to the rule it is to approximate to the quantity

$$[a_{n+1}\,a_n\,\ldots\,a\,b\,\ldots\,b_{n-1}]$$

The two expressions become in this case

$[a_n$

$$[a_n..ab..b_n] - \frac{x-b_n}{a_{n+1}-b_n}\left([a_n..ab..b_n] - [a_{n+1}..ab..b_{n-1}]\right)$$

$$[a_n..ab..b_n] - \left([a_n..ab..b_n] - [a_{n+1}..ab..b_{n-1}]\right)$$

where again the factor $\frac{x-b_n}{a_{n+1}-b_n}$ is positive and less than 1. The same exception takes place here as above.

If we apply these general formulæ to the case most frequent in astronomical calculations in which p, q, r, s form an arithmetical progression, it will be immediately seen that the functions denoted by [ ] will then become the first, second, third, and higher differences, every one respectively divided by the product of all entire numbers to its index inclusively. We shall have

$$[p,q] = \Delta P, \quad [p,q,r] = \frac{\Delta^2 P}{1.2}, \quad [p,q,r,s] = \frac{\Delta^3 P}{1.2.3}$$

where the equal intervals $q-p$, $r-q$, &c. are considered as unities. If we put $x-p = t$ expressed in these unities, and write throughout for $x-q \ldots . (x-p) - (q-p)$ $x-r \ldots . x-p - (r-p)$ the formula II. will become

$$(II)^* \quad X = P + t.\Delta P + \frac{t.t-1}{1.2}\Delta^2 P + \frac{t.t-1.t-2}{1.2.3}\Delta^3 P.....$$

the common formula for interpolation.

But if we assume that Δ, Δ^2, Δ^3 denote the differences which lie alternately below and above the horizontal line which is drawn from the place of x, we shall have from (III) if $r-x = t$, or if x is between q and r:

$$(III)^* \quad X = R - t.\Delta Q + \frac{t.t-1}{1.2}\Delta^2 R - \frac{t.t-1.t+1}{1.2.3}\Delta^3 Q.....$$

or from (IV) if $x-r = t$, or if x is between r and s.

$$(IV)^* \quad X = R + t\Delta R + \frac{t.t-1}{1\cdot 2}\Delta^2 R + \frac{t.t-1.t+1}{1.2.3}\Delta^3 R.....$$

If the argument in the last formulæ were *descending* instead of *ascending*, it would only be necessary to change the signs of the terms in both, if t is always to be considered as positive. For the successive correction of the differences, we obtain

$$X = R - t\left\{\Delta Q - \frac{t-1}{2}\left\{\Delta^2 R - \frac{t+1}{3}\left\{\Delta^3 Q - \frac{t-2}{4}\left\{\Delta^4 R \ldots\right\}\right\}\right\}\right\}$$

$$X = R + t\left\{\Delta R + \frac{t-1}{2}\left\{\Delta^2 R + \frac{t+1}{3}\left\{\Delta^3 R + \frac{t-2}{4}\left\{\Delta^4 R \ldots\right\}\right\}\right\}\right\}$$

If

If t is exactly $= \frac{1}{2}$, or if x is exactly the mean between q and r, it is the same as to accuracy whether the interpolation proceed forward from q or backward from r. The first form would be by (IV)*

$$X = Q + \tfrac{1}{2}\Delta Q + \frac{\frac{1}{2}\cdot-\frac{1}{2}}{1.2}\Delta^2 Q + \frac{\frac{1}{2}\cdot-\frac{1}{2}\cdot-\frac{3}{2}}{1.2.3}\Delta^3 Q$$

and the second by (III)*

$$X = R - \tfrac{1}{2}\Delta Q + \frac{\frac{1}{2}\cdot-\frac{1}{2}}{1.2}\Delta^2 R - \frac{\frac{1}{2}\cdot-\frac{1}{2}\cdot-\frac{3}{2}}{1.2.3}\Delta^3 Q$$

In adding them together all odd differences disappear; and if the respective sums of the even differences which are on the same horizontal line with Q and R are denoted by k', k'', &c. or if we put

$$Q + R = k; \quad \Delta^2 Q + \Delta^2 R = k'; \quad \Delta^4 Q + \Delta^4 R = k'' \text{ &c.}$$

the formula will be

$$(V)^* \quad X = \tfrac{1}{2}k - \frac{1.1}{2.4}\frac{k'}{2} + \frac{1.1.3.3}{2.4.6.8}\frac{k''}{2} - \frac{1.1.3.3.5.5}{2.4.6.8.10.12}\frac{k'''}{2} \cdots$$

$$= \frac{1}{2}\left\{k - \frac{1}{8}\left\{k' - \frac{3}{16}\left\{k'' - \frac{5}{24}\left\{k''' - \cdots\right\}\right\}\right\}\right\}$$

In using this formula we may again dispense with the regard to the signs by another consideration. If we designate the two differences which form any k, by β and β', and the next preceding and following ones by ${}'\beta$ and β'', and form this arrangement:

${}'\beta$		
	$\beta - {}'\beta$	
β		$\beta' - 2\beta + {}'\beta$
	$\beta' - \beta$	
β'		$\beta'' - 2\beta' + \beta$
	$\beta'' - \beta'$	
β''		

we shall have if $k^n = \beta + \beta' \qquad k^{n+1} = \beta'' - \beta' - \beta + {}'\beta$ $= \beta'' + {}'\beta - k^n$, or $k^n + k^{n+1} = \beta'' + {}'\beta$. But the correction has always this form $k^n - \alpha k^{n+1}$ where α is positive and < 1. The correction applied to k^n or to $\beta + \beta'$ will consequently always have the effect of rendering the sum $\beta + \beta'$ more distant from the sum of the preceding and following differences, excepting the case in which k^{n+1} has changed its sign by a former correction, which is easily observed in making several successive interpolations, and will never lead to errors. The last formula (V)* is so accurate, and at the same time so convenient, that in calculating a table it will be best to calculate the accurate values for intervals which are distant by a whole power of 2, and to find the intermediate values by this formula.

As an example, we will take the longitude of the moon for the

the above calculated occultation on April 5. We have from the Ephemeris:

		λ	Δ	Δ^2	Δ^3	Δ^4
April 4.	0^h	$152^\circ\ 15'\ 56'',6$				
	12	158 15 45,5	$+5^\circ\ 59'\ 48'',9$			
5.	0	164 13 46,2	5 58 0,7	$-1'\ 48'',2$		
	12	170 10 21,8	5 56 35,6	1 25,1	$+23'',1$	
6.	0	176 5 54,2	5 55 32,4	1 3,2	21,9	$-1'',2$
	12	182 0 42,8	5 54 48,6	0 43,8	19,4	2,5

In order to find the longitude for April 5. 7^h we must proceed from April 5. 12^h and apply formula (III)*. The factors $x-a$, $x-b$, &c. in V and VI, always divided by the number expressing the order of the difference, are the same as the quantities denoted in (III)* by t, $\frac{t-1}{2}$, &c.; we have, therefore, these factors of correction $\frac{5}{12}$, $\frac{7}{24}$, $\frac{17}{36}$, $\frac{19}{48}$; and reversing the order, $\frac{19}{48}$, $\frac{17}{36}$, $\frac{7}{24}$, $\frac{5}{12}$.

The correction of the third difference by the fourth is $\frac{2,5\,.\,19}{48} = 1,0$; and this is to be applied, without regard to the sign, in such a manner as to approximate 21,9 to 19,4. The corrected third difference is consequently 20,9. Hence the second will be $= 1\,.\,3,2 + \frac{17}{36}\,.\,20,9 = 1\,.\,13,07$, as the correction is to effect an approximation to 1 . 25,1. The corrected first difference now becomes $5\,.\,56\,.\,35,6 - \frac{7}{24}\,.\,73,07 = 5\,.\,56\,.\,14,29$ for the same reason. If we take $\frac{5}{12}$ of this quantity and subtract it from 170 . 10 . 21,8, we have April 5. 7^h ... $167^\circ\ 41'\ 55'',85$. If we had proceeded contrary to the above rule, from April 5. 0^h by formula (IV)*, the factors would have been $\frac{7}{12}$, $\frac{5}{24}$, $\frac{19}{36}$, $\frac{17}{48}$, and the corrected differences successively 22,3; 1 . 13,3; 5 . 56 . 50,87, by which the same longitude would have been obtained. In taking due notice of the signs, it will be seen that the above-given rule perfectly agrees with the change of signs in this example.

In order to perceive the facility of the interpolation towards the middle by formula (V)*, let it be required to find the longitudes for April 5. 6^h and 18^h. The fourth differences being uncertain, it is not absolutely necessary to take them in; and their influence will only be sensible if they are greater than

in

in the present case, as the sum k'' is to be multiplied by $\frac{1}{2} \cdot \frac{1}{8} \cdot \frac{3}{16} = \frac{3}{256}$. We have consequently for

6^h ... $k' = -2.28,3$ ... $-\frac{1}{8}k' = +18,54$
18^h ... $k' = -1.47,0$ ... $-\frac{1}{8}k' = +13,38$

And next:

April 5.	0^h	164° 13′ 46″,2				
				+2.58.27,1		
	6	167 12 13,3			−18,6	
				58. 8,5		
	12	170 10 21,8			15,6	
				57.52,9		
	18	173 8 14,7			13,4	
				57.39,5		
6.	0	176 5 54,2				

Interpolating again into the middle, we have for

9^h ... $k' = -34,2$ ..... $-\frac{1}{8}k' = +4,3$.

April 5.	6^h	167.12.13,3		
			+1.29.6,4	−4,3
	9	168.41.19,7		
			1.29.2,1	
	12	170.10.21,8		

from which by the common formula for interpolation (II)* for 7^h, $t = \frac{1}{3}$

	167.12.13,3
+	29.42,13
+	0,48
7^h ...	167.41.55,9 as above.

One might have dispensed again with the attention to the signs in interpolating into the middle, because it appears at the first view that k must be augmented.

If the interpolation is not to be for entire hours, but for a time which contains single seconds, it will be sufficiently accurate, in calculating the factors of correction for the higher differences, to substitute for the true t an approximate fraction. Thus if it is required to find the longitude for the time of the reappearance of 82 *Leonis*, $7^h\ 24'\ 16''$, we shall have proceeding from April 5. 12^h, $t = \frac{4^h\ 35'\ 44''}{12^h}$, for which the approximate value $\frac{5}{13}$ will be obtained.

The factors will therefore be $\frac{8}{26}$, $\frac{18}{39}$, $\frac{21}{52}$; the corrected differences 20″,9, 1′ 12″,8, 5° 56′ 13″,20. Applying to the latter the exact value of t, we obtain $7^h\ 24'\ 16''$...167° 53′ 56″,7, which agrees with the interpolation from the values found for 6^h, 9^h, and 12^h.

XIV. *On the Discordancies in the Results of the Methods for determining the Length of the simple Pendulum.* *By* Francis Baily, *Esq. F.R.S. &c. &c. &c.**

IT is well known to many persons that I have, for some time past, been engaged in making experiments on the convertible pendulum, with a view to satisfy myself of the accuracy of the generally received determination of the length of the simple pendulum, vibrating seconds, in this latitude. The result of those experiments has convinced me that we are, *at present*, very far from possessing in that instrument a method of deducing a *standard measure*. The pendulum employed was one similar to that which has been already described in the Phil. Mag. for August last, page 137; and is in fact nothing more than a plain straight bar of brass, about 62 inches long, 2 inches wide, and $\frac{3}{8}$ of an inch thick; without any moveable weights or sliding pieces: and the knife edges are so placed that the vibrations made on them are synchronous with each other. The distance between the knife edges (the determination of which is by far the most troublesome and difficult part of the process) has been determined from a mean of nearly one hundred comparisons with Sir George Shuckburgh's standard scale; which was kindly entrusted to me for that purpose, by the Council of the Royal Society, who now possess that invaluable instrument. This distance is 39·3069 inches: and the number of synchronous vibrations made on the knife edges, in a mean solar day, corrected for the arc, for the temperature, for the reduction to a vacuum, and for the rate of the clock, is 86208·70: consequently, the length of the simple pendulum will be

$$\left(\frac{86208{\cdot}7}{86400}\right)^2 \times 39{\cdot}3069 = 39{\cdot}1330 \text{ inches.}$$

But, Captain Kater makes the length of the simple pendulum (reduced to the level of the sea) equal to 39·13929 inches. If we strike off the last two figures, for the amount of the correction for reducing it to the level of the sea, we shall have, in round numbers, 39·139 inches as the value of Captain Kater's measure, determined near the same spot as my own: and it will be unnecessary to carry our inquiries into the value of the *fourth* figure in the decimal, when we disagree so much in the value of the *third* figure.

Knowing the accuracy with which Captain Kater's experiments were conducted, and having minutely examined every step of the process detailed by him in his excellent paper on

* Communicated by the Author.

the convertible pendulum, I was naturally led to conclude that I had inadvertently committed some error, which had escaped my repeated examination. But my suspicions were removed by the result of some experiments on a pendulum of another kind; and which has presented anomalies still more remarkable.

It has been shown by M. Prony, in his *Leçons de Méchanique Analytique*, vol. ii. page 340, that we may determine the length of the simple pendulum, by knowing the distance between, and the number of vibrations made by, *three* knife edges placed parallel to each other, and in the same vertical plane: since these elements are sufficient to enable us to determine not only the distance of either knife edge from the centre of gravity of the pendulum, but also the accelerative force of gravity, and consequently the momentum of inertia. I therefore caused a pendulum to be constructed on this principle; but, with the addition of another knife edge: thus obtaining *four* axes of suspension, instead of three. By which means, I could at any time get four combinations of three axes, and thus obtain a mean result much nearer the truth. I likewise caused the axes to be so placed that they should be convertible in pairs: that is, the knife edges A and C are so placed that the vibrations on them are synchronous, and the axes convertible: and the same with respect to the knife edges B and D. In a pendulum of this kind, therefore, we may determine the length of the simple pendulum, vibrating seconds, either by the knife edges A—C, or the knife edges B—D, according to Captain Kater's plan; or from any combination of three of the knife edges, according to the method of M. Prony; which, as it has not yet appeared in any English work, I shall here briefly describe, although at present I shall not make any practical use of it.



In the construction of Prony's pendulum it is not essential that the knife edges should be placed at different ends of the bar: unless it be intended that they should be convertible. But it will be much more convenient that they should be so situated: and that they should also be so placed that each pair may be, as nearly as possible, equally distant from the centre of gravity. On this principle, therefore, it follows that two of the three axes, chosen for the solution of the problem, will be on one side of the centre of gravity; and the other, on the opposite side. Let the distance (in inches) between the extreme axes be denoted by Δ: and let the distance between the middle axis and that axis which is on the

the same side as it, with respect to the centre of gravity, be denoted by δ. In order to avoid confusion, I shall always suppose that the pendulum, when referred to, is placed with the same end uppermost; by which means we may, in all cases, denote the three axes, above alluded to, by the designation of *upper*, *middle*, and *lower* axes: and *each* of the four combinations of three knife edges will give the length of the simple pendulum, agreeably to the formula of M. Prony, which is as follows.

By determining the number of vibrations, made in a given time, by each of the knife edges, we may obtain for the upper, middle, and lower knife edges respectively, the quantities n', n'', n'''; each of which represents a quantity (n) of the form $\left(\frac{T}{\pi N}\right)^2$: where T denotes the mean solar time (expressed in seconds) employed in making N vibrations; and π the circumference of the circle, diameter equal to unity. If T represent a mean solar day (=86400 seconds), N will consequently denote the number of vibrations made in a mean solar day: the value of N being always supposed to be corrected for the magnitude of the arc, the expansion of the pendulum, the reduction to a vacuum, and the rate of the clock. Either of the above quantities (n', n'', n''') thus deduced, being multiplied by the accelerative force of gravity (g), will give the length of the pendulum synchronous with a pendulum corresponding to its respective axis: and by multiplying this length by $\left(\frac{N}{86400}\right)^2$ we obtain the length of the simple pendulum vibrating seconds of mean solar time, at the given place.

The value of g is determined by means of a quadratic equation in the following manner. Make

$$\begin{aligned} \nu' &= n''' + n' \\ \nu'' &= n''' + n'' \\ \nu''' &= n'' - n' \end{aligned}$$

$$\begin{aligned} a &= 2(\delta\nu' + \Delta\nu''') \\ b &= \delta^2\nu' + 2\delta\Delta\nu'' + \Delta^2\nu''' \\ c &= \delta\Delta(\Delta n'' + \delta n''') \end{aligned}$$

Then will the distance (x) of the upper axis from the centre of gravity, the accelerative force of gravity (g), and the momentum of inertia (μ), be found from the following equations,

$$x = \frac{b}{2a} \pm \sqrt{\left(\frac{b}{2a}\right)^2 - \frac{c}{a}}$$

$$g = \frac{\delta(2x-\delta)}{n''\delta - \nu'''x} = \frac{\Delta(2x-\Delta)}{\delta x - \Delta n'''}$$

$$\mu = x(gn' - x)$$

And the lengths of the three pendulums will be respectively,

$$\text{upper} = g n' = x + \frac{\mu}{x}$$

$$\text{middle} = g n'' = (x - \delta) + \frac{\mu}{(x-\delta)}$$

$$\text{lower} = g n''' = (x - \Delta) + \frac{\mu}{(x-\Delta)}$$

and either of these values, being multiplied by $\left(\frac{N}{86400}\right)^2$, will give the length of the simple pendulum vibrating seconds: where N must be taken equal to the number of vibrations corresponding to the axis chosen for the multiplicand.

It is in this manner that I propose at some future time to treat the *definitive* results which may be obtained by the pendulum here alluded to. The numerical operation, however, is so troublesome, the quantities determined by the experiments so mixed up with every step of the process, and the introduction of a slight error affects so materially the final result, that I have considered it more satisfactory, in the *present view* of the subject, to deduce the length of the simple pendulum by the same means that I have adopted in the former pendulum: viz. by considering each *pair* of synchronous knife edges as convertible. That is, by considering the knife edges A and C as convertible, and the knife edges B and D as convertible: thus assuming them as *two* independent *convertible* pendulums, *on the same bar*.

From a mean of 8 measurements at various times, and differing very little from each other, and from a mean of 8 sets of experiments of about two hours each, on *each* knife edge, differing also very little from each other (corrected as in the former cases), I find that the distance between A and C is 39·3038 inches, and the number of synchronous vibrations 86218·3: and that the distance between B and D is 39·3084 inches, and the number of synchronous vibrations 86204·6. Consequently the length of the simple pendulum will be

$$\text{by A . C} = \left(\frac{86218{\cdot}3}{86400}\right)^2 \times 39{\cdot}3038 = 39{\cdot}1386$$

$$\text{by B . D} = \left(\frac{86204{\cdot}6}{86400}\right)^2 \times 39{\cdot}3084 = 39{\cdot}1307$$

The first of these corresponds very nearly with the value deduced by Captain Kater: but whence arises the discrepancy between the two results; and the discrepancy of both of them from the former result? The form and construction of this pendulum are precisely similar to the one described in the first part of this communication; except that it is double the thickness: which, on the whole I consider a disadvantage, although not

not at all bearing on the point in question. I ought not however to omit mentioning that, in order to render the respective knife edges synchronous, I caused a hole to be drilled at each end, and inserted some pieces of *lead*. But this, as far as our present knowledge of the pendulum extends, will have no other effect than to increase the specific gravity of the pendulum; and consequently to diminish, in a slight degree, the correction for the reduction to a vacuum; and which moreover will *equally* affect all the knife edges. The two ends are symmetrical.

As these are the first and only experiments (as far as my information extends) that have been made on the convertible pendulum, since those by Captain Kater, they may probably be the means of inducing others to take up and investigate the subject. I consider them, at present, only as *preliminary:* since it appears to me to be a waste of time to attempt any much greater degree of exactness, or to aim at any *definitive* results, when discordancies of such magnitude present themselves at the commencement of our inquiries, and for the existence of which we are unable to account. I am aware that M. Bessel has lately made a number of very interesting and valuable experiments on pendulums of various kinds, and under a variety of different circumstances: and that, from the result of those experiments, there is reason to believe that the common correction for the reduction to a vacuum is not the same for the two positions of the convertible pendulum. But I am not aware that he has been able to deduce any formula whereby we may determine the true correction which ought in every case to be applied. The public, however, wait with much impatience for the publication of his important discoveries. Probably the only accurate mode of determining the amount of this correction, is by actual experiment:—by swinging every convertible pendulum in both positions of the knife edges; first in the open air, and afterwards *in vacuo:* and I believe that a convertible pendulum is about to be treated in this manner, by means of a new apparatus now erecting at the Royal Observatory at Greenwich.

Whether the result of those experiments may tend to remove the discordancies here alluded to, I cannot pretend to say. If they should fail, it will be evident that the pendulum will not afford us the means of obtaining a correct and permanent standard, and which, if ever lost or destroyed, may be reproduced upon certain and unerring principles: but that we must seek for some other mode of deducing so invaluable a measure.

In the fourth volume of the *Base du Systême Métrique*, page 587, M. Biot has given the mean result of the experiments of MM. Borda,

MM. Borda, Bouvard, Mathieu, and himself, on the length of the pendulum at Paris: which, by adding the known difference in the number of vibrations between Paris and Greenwich, will make the length of the simple pendulum, at this latter place, equal to 39·1379 inches. So that we have here also another discordance, amounting to more than ·001 of an inch. I am aware that there is supposed to be a slight constant difference between the observations at Greenwich and London: but I believe that some recent experiments do not exactly accord with the theory on this point. This will, however, very shortly be more fully determined.

Were I to construct another convertible pendulum I would make the distance between the two knife edges exactly 36 inches; or as nearly so as the artist could effect it. I presume that Captain Kater selected the distance somewhere between 39·4 and 39·5 inches, in order that the proposed coincidences might be accommodated to the pendulum of the clock: at least, this circumstance weighed materially with myself, when I ordered the knife edges to be placed as nearly as possible 39·3 inches asunder. This, however, I find by experience to be a minor consideration; and inconveniences of a greater kind present themselves by adopting this plan. It is much better to select the best and most convenient length for the distance between the knife edges; and to make the pendulum of the clock subservient to the intervals required. Now, the best and most convenient length must be the very measure we are in search of; namely, the *standard yard:* for, when any other distance is fixed on, we may be in doubt with what part of the standard scale such distance ought to be compared. Captain Kater took the mean of 20 several lengths of 39·4 inches each; "commencing from zero of the scale, and advancing by single tenths through the space of two inches." But, if he had made a comparison with the same distance (39·4) at the *other end* of the scale, he would have found a difference amounting to above ·0003 of an inch, in that length. Now, the distance, with which Sir George Shuckburgh himself compared the several standard yards in his time, is marked on the scale, and extends from 10 inches to 46 inches: and this I conceive to be the proper and only *unit of measure* which ought to be resorted to: unless we take the mean of the whole scale, as hereafter alluded to. The fact is, that the standard scale of Sir George Shuckburgh (although otherwise in excellent preservation) is not exactly straight, but is very slightly bent and twisted: and more so at one end (the zero end) than at the other. The bar is nearly 68 inches long, 1·4 inches wide, and 0·4 inches thick; and formed of *two distinct pieces* of brass, fastened

fastened and riveted together; the upper part, on which the divisions are cut, (equal to $\frac{1}{3}$ of the thickness) being of *plate* brass; and the under side (equal to the other $\frac{2}{3}$) being of *cast* brass. Whether it is owing to this circumstance, or to any slight injury it may have received either in its packing (which is *now* certainly not in the best order), or from some other cause, it might be difficult to decide at the present day; but it has a very small curvature upwards at the ends, of sufficient magnitude, however, to enable a common playing card to be passed with ease 2 or 3 inches underneath the zero end, when lying on a straight and plane plank: at the other end, a piece of thin paper might be passed, about the same distance. That part of the scale, which may be called the *standard yard*, and which (as above stated) extends from 10 inches to 46 inches, does not appear to be affected by this distortion; and consequently seems to be the most proper portion of the scale to be considered as the *unit of measure*.

In Captain Kater's "Account of the comparison of various British standards of linear measure," inserted in the Phil. Trans. for 1821, he has given the result of a comparison of 36 inches on four several standards, with the same distances on Sir George Shuckburgh's scale: but he has not stated *what part* of Sir George Shuckburgh's scale was selected. In his account, however, of the adjustment of the standard yards (Phil. Trans. 1826, page 44), he states, that the distance there used was taken from zero to 36 inches: leaving it therefore to be inferred that the same distance was used on the former occasion. But, would it not have been more satisfactory to have used that very distance which Sir George Shuckburgh himself adopted in his comparisons: viz. from 10 to 46 inches? or (which would perhaps have been more correct, though far more troublesome) to have taken a mean of all the 240 distances of 36 inches each, that might have been measured on the scale; advancing by successive tenths from zero to 24 inches?

There is also another circumstance connected with these measurements, which ought to be borne in mind. Captain Kater states (Phil. Trans. 1821, page 78) that his microscopes were attached to a stout mahogany bar, 36 inches long, and that this bar was *laid upon the scale:* which he considered an important advantage, inasmuch as the microscopes, being once adjusted to distinct vision, would not require re-adjusting when placed upon another scale. But he seems to have overlooked the circumstance that the *bent* end of Sir George Shuckburgh's scale would not present the same reading when a heavy weight was placed upon it: neither do I think it adviseable at any time to resort to such a method. These are points which ought to be taken into consideration at any future time, if the

pendulum

pendulum (as I presume it will be) should ever be re-measured and re-swung with a view to obtain a more correct and permanent comparison for a standard measure; for, in a national work, no labour or expense ought to be spared, in order to obtain the greatest possible accuracy.

I ought not to omit mentioning that the two convertible pendulums (the one of iron, and the other of copper) belonging to the Astronomical Society, and now in the care of Captain Foster, in his voyage of experiment and discovery, are formed on precisely the same plan, as the pendulum alluded to in the first part of this communication. I had not an opportunity of measuring the distances between the knife edges, previous to his departure: but, on his return, it will be interesting to ascertain whether those pendulums indicate anomalies similar to those which have been the subject of this communication.

January 20, 1829. FRANCIS BAILY.

XV. *Some Observations on* Mr. Meikle's *Reply, published in the last Number of the Quarterly Journal of Science. By* JAMES IVORY, *Esq. M.A. F.R.S. &c.**

MR. MEIKLE seems resolutely bent on effecting the *thorough reform*, and on weeding out every blemish from mathematical science. For my part, I am fully resolved to oppose no obstacle to the accomplishment of so laudable a project. On the contrary he may reckon upon it as a thing not doubtful, that I shall approve and adopt every improvement he may be able to establish on good grounds.

He is no less bent on giving to what he calls my formula any shape, and on making any use of it, he pleases. There seems, however, to be some misgiving on this point; for, in a note, he calls upon his readers to recollect what the formula is. On the other hand, I call upon them to go back to the principles from which the formula is deduced, this being the best way to judge of its import and to guide in its right application.

In this Journal for February 1827, p. 94, I have arrived at this conclusion:

"The heat extricated from air when it undergoes a given condensation, is equal to $\frac{3}{8}$ of the diminution of temperature required to produce the same condensation, the pressure being constant."

And as the same quantity of heat, which is evolved by a

* Communicated by the Author.

given

given condensation, is absorbed by an equal dilatation, the short proposition enunciated, without any formula, contains the whole of my doctrine.

In this Journal for November 1828, I have deduced the same conclusion immediately from the usual theory of the thermometer; that is, on the supposition that the absolute heat, or, which is the same thing, the sum of the heat of temperature and the latent heat, is proportional to the indication of the thermometer, or to the change of volume when air varies under a constant pressure. This is expressed, p. 323, by the equation

$$i = (k-1)\,\tau = \tfrac{3}{8}\tau,$$

τ being the change of temperature, and i the variation of latent heat.

My opinion on this subject was suggested by the very ingenious and important experiment of MM. Clement and Desormes. It appears to me that we learn nothing directly from that experiment, respecting the relation between the heat evolved when air is condensed, and the magnitude of the condensation: what it does bring us acquainted with, is the proportion between the heat evolved and the change of temperature, supposing the air to vary under a constant pressure. It is proved by repeating the experiment under different pressures and temperatures, that the proportion mentioned is constant within certain limits; which agrees with the conclusion deduced from the theory of the thermometer. It might therefore have been inferred *à priori*, that the proportion is constant, but its numerical value can only be found by experiment.

The observations I have made are not intended to defend my opinion, but to rescue it from misrepresentation. Mr. Meikle makes a great handle of the algebraic formulas, and, by a sort of legerdemain of which he is a master, extracts from them many absurdities. He regards not the principles of the explanation I have given; he is content to play tricks with the algebraic expressions. All the absurdities he finds, are of his own making. In this Journal for November 1828, p. 324, I have obtained these expressions,

$$i = \frac{1}{\beta}(1 + \alpha\theta)\left(\frac{V}{V'} - 1\right),$$

$$i = \frac{1}{\beta}(1 + \alpha\theta)\left(\frac{\varrho'}{\varrho} - 1\right):$$

here V' is the volume, ϱ' the density, and θ the temperature, of the given mass of air; and i is the variation of latent heat when the volume changes from V' to V, and the density from ϱ' to ϱ.

Now it is manifest that, the mass of air remaining the same, the quantity $\frac{1+\alpha\theta}{V'}$ has the same value in all circumstances; it is equal to $\frac{1}{M}$, putting M for the bulk of the given mass of air reduced to zero of the thermometer, the pressure being constant. The first of the foregoing formulas is therefore,

$$i = \frac{1}{\beta} \times \frac{V - V'}{M}.$$

The variation of temperature for the same change of volume, is

$$\tau = \frac{1}{\alpha} \times \frac{V - V'}{M}.$$

Now, in Fahrenheit's scale, $\frac{1}{\alpha} = 480°$, and $\frac{1}{\beta} = \frac{3}{8} \times \frac{1}{\alpha}$, therefore, $i = \frac{3}{8} \times 480 \times \frac{V - V'}{M} = 180° \times \frac{V - V'}{M}$.

In order to find the heat i, we must therefore convert the difference of volume $V - V'$, into degrees at the rate of 180° for M, which is the bulk of the given mass of air at the temperature zero; just as the heat of temperature is found by converting the same difference of volume into degrees at the rate of 480° for the same bulk M. In the second formula, we have $(1 + \alpha\theta)\varrho' = D$, D being the density of the mass of air when it is reduced to the bulk M; and thus we readily obtain

$$i = 180° \left(\frac{D}{\varrho} - \frac{D}{\varrho'}\right),$$

which is manifestly equivalent to the other expression. I am not aware that it is possible to warp these formulas from their obvious and unequivocal meaning; and as my sole intention is to explain what I have written, and to rescue it from the fangs of Mr. Meikle's algebra, which perverts whatever it touches, it seems unnecessary to add any thing further. But in quitting this subject, to which I will not return, I cannot help expressing my surprise at finding myself involved in such petty disputation.

Jan. 13, 1829. JAMES IVORY.

XVI. *On the Method of deducing the Difference of Longitude from the Azimuths and Latitudes of two Stations.* *By* JAMES IVORY, *Esq. M.A. F.R.S. &c.**

I SHALL now extend to all solids of revolution that are little different from a sphere, the same property which is proved of the oblate elliptical spheroid of revolution in the last Number of this Journal.

* Communicated by the Author.

Taking

Taking any station on the surface of the solid, let y denote the ordinate of the meridian perpendicular to the equator, and x the distance of y from the centre: put

$$\varrho = y\frac{\sqrt{dx^2+dy^2}}{dx};\quad \tau = \frac{x\,dx+y\,dy}{dx};$$

then ϱ is the normal, or the perpendicular to the surface of the solid, limited by the equator, and τ is the distance of the foot of the normal from the centre. The latitude, or λ, is the angle which ϱ makes with the equator; and therefore,

$$x = \tau + \varrho\cos\lambda,\quad y = \varrho\sin\lambda.$$

For any other station we have similarly,

$$x' = \tau' + \varrho'\cos\lambda',\quad y' = \varrho'\sin\lambda':$$

And if ω be the difference of longitude, the three coordinates of the second station referred to the meridian of the first, will be,

$$x'\cos\omega = (\tau' + \varrho'\cos\lambda')\cos\omega$$
$$x'\sin\omega = (\tau' + \varrho'\cos\lambda')\sin\omega$$
$$y' = \varrho'\sin\lambda'.$$

Put m and m' for the azimuths at the first and second stations: then if we make two planes pass, one through ϱ and the second station, and the other through ϱ' and the first station, we shall obtain these equations,

$$Q = \tau\sin\lambda\cos\lambda' - \tau'\sin\lambda'\cos\lambda,$$
$$\frac{\sin\omega}{\tan m} + \cos\omega\sin\lambda - \cos\lambda\tan\lambda' = \frac{1}{\cos\lambda'}\cdot\frac{Q}{x'},$$
$$\frac{\sin\omega}{\tan m'} + \cos\omega\sin\lambda' - \cos\lambda'\tan\lambda = -\frac{1}{\cos\lambda}\cdot\frac{Q}{x}. \qquad (A')$$

But in a spherical triangle, as described at p. 24 of the last Number of this Journal, we have,

$$\frac{\sin\omega}{\tan\mu} + \cos\omega\sin\lambda - \cos\lambda\tan\lambda' = 0,$$
$$\frac{\sin\omega}{\tan\mu'} + \cos\omega\sin\lambda' - \cos\lambda'\tan\lambda = 0;$$

and by subtracting these equations from the former, we get,

$$\mathrm{Sin}\,(\mu-m)\times\frac{\sin\omega}{\sin\mu\sin m} = \frac{1}{\cos\lambda'}\times\frac{Q}{x'},$$
$$\mathrm{Sin}\,(m'-\mu')\times\frac{\sin\omega}{\sin\mu'\sin m'} = \frac{1}{\cos\lambda}\times\frac{Q}{x}.$$

Now, $\frac{\sin\omega}{\sin\mu} = \frac{\sin\beta'}{\cos\lambda'}$, and $\frac{\sin\omega}{\sin\mu'} = \frac{\sin\beta'}{\cos\lambda}$; therefore,

$$\mathrm{Sin}\,(\mu-m) = \frac{\sin m}{x'}\times\frac{Q}{\sin\beta'},$$
$$\mathrm{Sin}\,(m'-\mu') = \frac{\sin m'}{x'}\times\frac{Q}{\sin\beta'}.$$

Let φ and φ' denote the depressions of the chord γ below the horizons of the first and second stations; then, according to what is shown at p. 242 of this Journal for October 1828, we shall have these two equations:

$$x' \sin \omega = \gamma \cos \phi \sin m$$
$$x \sin \omega = \gamma \cos \phi' \sin m';$$

wherefore, $\frac{\sin m}{x'} \times \cos \varphi = \frac{\sin m'}{x} \times \cos \phi'.$

By combining this equation with the former one, we readily obtain,

$$\text{Sin } (\mu - m) \cos \phi = \sin (m' - \mu') \cos \phi'.$$

On the suppositions made, $\mu - m$ and $m' - \mu'$ are small arcs; also cos ϕ and cos ϕ' are always nearly in a ratio of equality; wherefore we may conclude without sensible error, that

$$\text{Sin } (\mu - m) = \sin (m' - \mu'),$$
$$m + m' = \mu + \mu'$$

$$\text{Tan } . \frac{\omega}{2} = \frac{\cos \frac{\lambda - \lambda'}{2}}{\sin \frac{\lambda + \lambda'}{2}} \times \tan \frac{m + m'}{2}.$$

This demonstration comprehends the elliptical spheroid as a particular case.

When the two latitudes are equal, cos φ = cos φ'; and we learn from the equations (A′) that m and m' are respectively equal to one and another to μ and μ'. But the formula for the difference of longitude is true, independently of the situation of the stations.

In an elliptical spheroid when the latitudes are equal, the excentricity disappears from the equations (A′), and it is therefore indeterminate. And when the latitudes are very nearly, although not exactly, equal, there is so near an approach to the condition which makes the excentricity indeterminate, that no dependence can be practically placed on any result respecting the figure of the earth obtained by means of the equations, or by means of the angles they contain. In order to find the excentricity, we must have recourse to the measured distance between the stations, as I have pointed in the last Number of this Journal.

If we put s for the geodetical line between the stations on the spheroid, and represent by σ a line traced on the surface of the sphere, in such a manner that every two points of s and σ that are upon the same meridian, have the same latitude; then the sum of the three angles of the triangle on the surface of the spheroid, that is, the sum of ω and the inclinations of s to the meridians at its extreme points, will exceed 180° by a quantity proportional to the surface of the trilateral figure on the

the sphere contained by σ and the two meridians. This proposition is rigorously true, and is only a particular case of a more general theorem demonstrated by Professor Gauss in the Memoirs of the Royal Society of Göttingen: but it must be observed that the trilateral figure on the surface of the sphere is not a spherical triangle, because the line σ is not contained in the plane of any great circle. And as the line σ depends upon the geodetical line s, which, supposing the latitudes and the difference of longitude to remain unchanged, varies with the excentricity, it follows necessarily that the sum of the azimuths at the extremities of s, is not independent of the excentricity, but varies from one spheroid to another. The sum of the azimuths mentioned is not, in any spheroid, exactly equal to the sum of the angles at the base of a triangle on the surface of the sphere formed by the two meridians, and a great circle which cuts them at the latitudes of the stations.

Jan. 13, 1829. J. Ivory.

XVII. *On the Nature of Light and Shadow, demonstrating that a Black Shadow can be rarefied, without Refraction, into all the Colours of the Rainbow.* By Joseph Reade, *M.D.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

I BEG leave to return you my thanks for the correctness with which you have published my experiments on light*, and I hope the following novel experiment may be favourably received by your scientific readers.

Experiment 1.—Having placed a table at about ten feet from a well lighted window, I placed on it a candle in a high candlestick. I now held a quire of white paper parallel to the table, and at right angles with the lighted candle: on holding this paper rather close to the blaze, two shadows were produced by means of a piece of coiled paper held immediately near the quire; the one next to the candle was a bright orange, the other a bright blue. On turning the quire of paper towards the window, so as to cut off the light of the candle, this orange shadow changed to a perfect black; and on turning the quire of paper towards the candle, and excluding the light of the sun, the blue shadow likewise changed to a perfect black. Here I changed orange and blue colours into black, and *vice versâ*, without any possibility of refraction. This experiment may be made by holding the paper behind the candle.

Experiment 2.—The former experiment was made with the paper between the candle and the window: I now held the paper close behind the candle, and perceived two shadows, the

* See Phil. Mag. vol. lxiii. p. 27, &c.

one

one orange, produced by the light of the window, rarefied by that of the candle; and the other blue, rarefied by that of the sun. On bringing these shadows on a straight line with the window, they overlapped, and produced one shadow of a perfect green colour. The orange shadow could be changed to a yellow by bringing the shadow near to the blaze of the candle; or it may be made a brown at a still greater distance: in like manner, the blue shadow could be changed to a perfect violet by removing the paper to a certain distance from the blaze, and likewise to indigo. Thus we have all the colours of the rainbow or spectrum, except red and purple: indeed, we have an extra colour, never to be found in the prism—brown.

Experiment 3.—About one o'clock I perceived a large spot of light reflected by the sun on the side-wall of my study, and it occurred to me that the colours might be different. Anxious to produce a red from a black shadow, having held the quire of white paper opposite this reflected light, and holding the coil of paper over it, I perceived two shadows, the one yellow, the other purple; and on holding a lighted candle near the purple, it changed to a lake, or perfect red. For the purpose of changing this red to a black, I stood between the paper and the side-window, so as to intercept the light coming from the clouds, and only to admit the reflected sunshine to the paper; when the purple immediately changed to a black, the candle being previously removed. Thus without any refraction have we changed a black shadow into all the variety of colours in the spectrum; for the most devoted admirers of the Newtonian doctrines cannot argue that the atmosphere between the candle and the paper was a refracting medium, or that it stopped some and transmitted others of the solar rays; all astronomers admitting that the rays coming from the sun are nearly parallel on account of the great distance. I forgot to remark, that on bringing the candle to act on the purple shadow, a blue shadow was formed as in the other experiments; and, consequently, there were three shadows on the paper,—blue, lake, and yellow; the blue rarefied by the candle, the lake produced by the sunshine, and the other formed by the light of the window; for it is well known that every different light forms a separate shadow. As to the idea that black proceeds from the absorption of the seven rays of compound light, it is completely upset by these experiments; for we cannot suppose that the quire of white paper was at one moment an absorbing substance, and at the next a reflecting one; therefore we must admit, contrary to the opinions of Boyle and Newton, that black is as much a reflected and independent colour as blue, red, or any other colour of the seven. I shall not take up the reader's

reader's time by quoting the opinions of Otto Guericke, Buffon, Bouguer, Melville and others, on blue shadows; as they all accounted for blue shadows on the Newtonian theory, and never dreamt that a black shadow could be changed into all the colours of the rainbow, supposing that the fainter rays were stopped in the atmosphere, and the blue reflected. Some years ago, when writing the "Experimental Outlines," I had not attended to this part of my subject sufficiently, therefore could not account satisfactorily for the green which Buffon saw on the garden wall at sun-set. This I now find proceeds from the overlapping of blue and yellow shadows rarefied by the light of the sun, and light reflected from the clouds, or the cliff of the mountain. As these philosophers were involved in a labyrinth as intricate as that of Rosamond's Bower, and from which no clue could ever extricate them,—I shall not attempt to follow them any further. I am, &c.

JOSEPH READE.

XVIII. *Observations on the Anticlinal Line of the London and Hampshire Basins, &c.* By P. I. MARTIN, *Esq.**

HAVING been lately engaged in an attempt to combine some of the evidence of the conjunctive operations of derangement and denudation in the formation of what are called the Basins of London and Hampshire, in a theory which I judge to be applicable, with some modifications, to almost all trough- or basin-shaped contortions of strata that have a conformable disposition; it may not be uninteresting to follow up the research with some observations naturally arising out of the subject, and which merit consideration, not only as confirmative of the theoretical opinions there developed, but also as highly illustrative of the problem so interesting to all the lovers of Nature,—the modification of the present surface of the globe, and the acts and agencies by which it has been effected.

In my Essay† on the Formation of the Valley of the Weald, I have attempted, in following up the ideas of Dr. Buckland and Mr. Scrope, on *Valleys of Elevation*, to show, that the protrusion of an "anticlinal line" between the Basins of London and Hampshire, or, which is tantamount to it, the depression of the parts constituting those basins across a fixed point, burst or broke up the intervening ones, and gave rise to the basins and to the valley of denudation which lies between them;

* Communicated by the Author.

† "A Geological Memoir on a part of Western Sussex, &c." London, 1828.

and

and that a double system of valleys and a particular line of drainage remained, as evidence of the fact, proper allowance being made for a contemporaneous or immediately consecutive diluvian action.

Fortunately for this theory, the greater part of it had been already made out by Dr. Buckland in the paper above alluded to*; and a double system of valleys, or the transverse sections of the chalk escarpments, which I have ventured to call "river fissures," made the medium of drainage, had been observed by Mr. Conybeare. I may also acknowledge in this place, that my observations upon Portsdown Hill, as a chalk outlier-by-protrusion, have been in part anticipated by the latter gentleman†, although he supposes it to originate in a simple undulation of the surface of the chalk, anterior to the æra of deposit of the higher strata. This is the notion apparently also of Mr. Webster, who, in his illustrative map in the second volume of the Geological Transactions, has connected its eastern extremity with the chalk of the South Downs. Protrusion presents itself every where in such close connection with denudation, and plays so large a part in the modification of all parts of the surface of the earth, that its recognition in all formations, from the highest to the lowest, cannot be too ample.

The anticlinal line which separates the two English Basins, commences near Devizes, or in the Vale of Pewsey, and elevates and causes the exposure of the great expanse of chalk which is discovered between the tertiary formations north and south of it ‡. Quitting the chalk in the Alton-Hills, it brings up the greensand or glauconite, in which it is continued on into Sussex. From the glauconite, at the head of the Weald Valley, it raises in succession the various beds of the Weald formation, or "Wealden," and crossing the Channel, gives rise to the denudation of the Boulonnois, and is finally lost in the chalk of Picardy; unless, which is very probable, it there assists to separate the tertiary formations of the Paris Basin from those of the eastern extremity of the London Basin, after it sinks under the North Sea.

In this course of about 200 miles, in a direct line east and west, or a little inclining to south-east and north-west, it presents

* Geol. Trans. vol. ii. New Series.

† Outlines of the Geology of England and Wales, Part I. p. 82.

‡ The great chalk dome of Hampshire and Wilts is in the line of elevation; but it is probable that more precise marks of dislocation may be traced in the line of country between Farnham and Devizes; forming a chain of valleys of which the Vale of Kingsclere is a part, and bringing the great eastern denudation into more strict relation with the western.

everywhere

everywhere the same geological features, except where it is broke in upon by the sea; and those features, as far as regards the Weald Valley, have long been considered as dependent upon denudation.

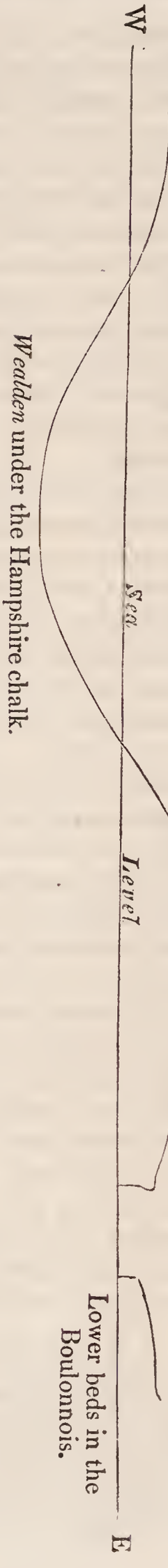
It might be supposed that this anticlinal ridge was the original form of the strata which compose it, and was one of those undulations which are supposed to take their rise at the period of deposit,—were it not for the appearance of a system of transverse valleys, corresponding with, and produced by cracks and fissures in the basset edges of its strata; with such divergences and ramifications of those fissures, and other signs of fracture, as might be expected to be produced in the stretching and bursting up of ponderous and frangible bodies.

But it will be said, that although the elevation of an anticlinal line explains the longitudinal fracture of the incumbent strata, it does not satisfactorily account for the transverse fissures; and we are naturally led to look for evidence of some obliquity in the long diameter of the ridge correspondent with them, and with a force acting transversely to it,—and we shall not be disappointed. The order of succession in the emergence of the inferior strata, and the manner in which they attain a geographical pre-eminence over the superior ones, in the direction of the short axis of the ridge, or north and south, are sufficiently obvious, and are familiarly known by the sections of Smith, Conybeare, &c. But the same order, in a direction east and west, or of the long diameter of the ridge, is not so apparent; but a gentler inclination in that direction is easily demonstrated. The lowest bed, brought up by the act of denudation on the English side of the Channel, belongs to the lower part of the Wealden; and it rises at Crowboro' Hill, about the middle, and in the widest part, of the Weald, to the height of 800 feet above the level of the sea; whilst, in the western part of the ridge, the same stratum may be computed to have sunk 900 feet* below it. This is proved by subtracting the thickness of the overlying strata at Inkpen Beacon, or the highest elevations of the chalk platform in Hampshire and Wilts. This moderate obliquity, a rise of 1700 feet in 80 or 100 miles, corresponds with the order of denudation†, and also explains

* It is not to be supposed that this is any thing more than an approximation to the true admeasurement.

† Mr. Murchison has observed the inclination of the lower beds towards the chalk of the Alton-Hills (Geol. Trans. vol. ii. New Series, p. 101), that is, westward, or in the direction of the long axis of the ridge; and this inclination or lateral bearing is to be observed in every considerable advance of the upper strata, toward the centre of the Valley of the Weald.

why the fissures remain, (to use the expression of Mr. Scrope,) "crevice-like gorges," instead of opening into broad expansions, like the longitudinal valley, produced by the opposite more sudden elevation. The curve here pointed out may be represented as in the margin.



This curve brings the anticlinal line into strict relation with those masses composed of concentric circles mantling round nuclei, amongst the older formations; and an ideal section of it, whether longitudinal or transverse, will exactly correspond with sections of such protrusions so often exhibited*.

Assuming it therefore as proved, that the strata above the chalk were continuous anterior to the convulsion which threw them, the chalk itself, and the strata below the chalk, into what has been called the basin shape, it follows of course that the act of denudation begins with the upper beds, and proceeds downwards to the lowest that are here exposed. And that the term denudation ought not to be confined, as it has hitherto been, in this instance, to the chalk and the Weald Valley only, but is common to them all. Looking more closely to the effect of this operation upon each stratum in succession, we find;—first, that if any formation higher and less ancient than the Bagshot sand, the strata of Headon Hill, or the "upper marine" of the London Basin, ever existed, it has been removed entirely, or is hid beneath the sea; and that of the above named, a small portion only remains. Of the London clay there is a larger expanse beveled off at the edge, as almost all clays are, and therefore presenting no escarpment. The plastic clay comes next, and is found to be in the same predicament, (except

* I have elsewhere observed, that longitudinal and transverse are merely conventional terms; as they apply to the exposed or basset edges of strata (see note 1 of my "Memoir"): and it would be easy to show that transverse valleys and a correspondent drainage are the natural and necessary consequences of obliquities in all protrusions; or rather, that no elevation or subsidence can exist without these conditions.

where

where its beds of sand, or more cohesive parts, have resisted the erosive power,) and is thinned out upon the chalk. The chalk next, being a stratum of greater induration, and presenting a less destructible fracture-edge, breaks down in an abrupt escarpment, where it has suffered disturbance enough to ensure its entire demolition; but where not so broken up, continues spreading over a large surface, and though cracked and furrowed in the same order as the other strata, remains in its place, dipping north and south under its upper coverings. Leaving the basset edge of the chalk, the act of denudation is found to have brought out the strata beneath, in ridges or furrows, according to the greater or less induration, the greater or less destructibility of their materials*; abrupt escarpments or fracture-edges presenting themselves in

* It is delightful to meet with confirmations of the community of character of diluvian abrasion or denudation in all parts of the globe. The following quotation will show, that Australia possesses the same phænomena of surface as we have been here descanting on.

"In this county (Argyle) you have several excellent samples of that singular appearance sometimes presented by the land in its state of nature, exhibiting, as you would suppose, the most striking evidences of former cultivation, in the regularly laid-out ridges apparently produced by the plough, which here and there intersect your path. I have seen twelve at least of these ridges, all contiguous and extending in length for two hundred yards and more, so evenly proportioned, that I do not think above a foot difference could be detected in any of their breadths; whilst I could almost have protested that I could perceive the very plough landings, and count their number in the ridges, which are usually about ten or twelve feet broad. The same appearances are more plentifully and strikingly portrayed at Bathurst and at Hunter's River. They occur always on gentle declivities, where there is a tenacious subsoil with loose superstrata, and are doubtless produced by the rain-torrents; but how this great regularity in their breadth is effected, is a problem of difficult solution. Here too I have witnessed, upon the tops of ridges, extensive beds of water-sand and water-gravel, mixed with fragments of shells, presenting the identical appearances you will observe upon the banks of rivers, or upon sea beaches."—*Cunningham's New South Wales*, vol. i. p. 116.

These are the remarks of an acute observer, unincumbered with geological prejudice, but falling nevertheless into the errors of false induction. And we cannot but be struck with the similarity of the appearances he describes to the phænomenon of the "parallel lines of Glen Roy," so ably described and ingeniously descanted on by Dr. MacCulloch, in the 4th volume of the Geol. Trans. The simple and easy solution of the problem there exhibited, is given by the universal act of abrasion. The projection of the indurated lines of stratified beds, and the erosion of the intervening more destructible parts, are the natural effect of watery friction acting contemporaneously, and with nearly equal force upon their perpendicular or oblique sections. The *relief* thus given to the indurated lines of stratification, is strikingly displayed in the glens alluded to, and their parallelism remarkable, because the same texture pervades all the rocks concerned in the formation of Glen Roy and its neighbouring valleys, and the same agencies operated over a certain extent of surface, and ruled the formation of

in the stony beds, and an eroded thinned-off surface in the clays. These phænomena are to be traced down to the lowest beds of the wealden, in the Weald Valley, or in the Wiltshire Vales, and down to the mountain limestone in the Boulonnois*.

In the study of the whole, or of a part of this anticlinal line, the naturalist who takes for his guide the image thus presented to his mind, will find all its variety of surface satisfactorily accounted for, and all its parts in harmony with each other. Evidence of elevation and subsidence, fracture, watery erosion, prominence or depression, all answering to the compound actions of convulsion and watery flood.

In carrying on this investigation a little further, and taking it for granted that all the formations above it have rested where we now find the wealden only,—a curious and almost unexpected result displays itself, if we picture the restoration of the lost materials. Crowboro', in Sussex, the highest geographical point of the lowest geological bed, rises 800 feet above the level of the sea 800
If to this we add for the remainder of the wealden above it, at a moderate computation 600
For the glauconite 500
For the chalk—Mr. Conybeare thinks that the thickness cannot be fairly judged by the vertical beds of the Isle of Wight, where it is 1300 feet; but it may at least be computed at 800
Plastic clay 700
London clay 400
Bagshot sand, the Headon Hill, or whatever other strata are known to lie on the London clay . . . 200

Feet 4000

Almost double the thickness here stated is given to the plastic clay by Mr. Webster†; but I have followed Mr. Conybeare, although I think that he has over-rated the expansion which he supposes to have occurred to this as well as to the chalk stratum in the vertical beds of the Isle of Wight. The extent of the superficies of the upper chalk of

the beds afterwards fractured and furrowed into valleys and mountain ranges. Similar, though less regular, lines may be observed in the sides of many hills composed of rocks of regular stratification, and always on eroded superficies of unequal densities.

* Proceedings of Geological Society, 1827; and Conybeare and Phillips's "Outlines," &c.

† Geol. Trans. vol. ii.

the

the South Downs, and its denudation there, inclines me to believe it to be of great thickness.

At a moderate computation, therefore*, supposing that no denuding flood had existed to carry away the materials, we should have had in the place of what is now the Weald Valley, a mountain far exceeding the highest of our English hills, and rising to half the height at which Dr. Buckland says relics of tertiary strata are still to be found in Alpine districts. If to this 4000 feet of elevation above our present sea level, we add the range of these strata below the German Ocean, we have much reason to suppose a still greater removal from the horizontal line. The average depth of the North Sea is less than 200 feet: how much of it is filled up with diluvium, and how much by strata which have escaped destruction by subsidence, or a minor elevation, is uncertain; but it is by no means impossible that a submergence may exist equal to the elevation which we see demonstrated upon the surface. At all events here is a valley where a mountain of no mean elevation once stood, or might have existed still, but for the act of another agency; and whether the operation of elevation, fracture and removal, took place under water at a higher or lower elevation of this part of the globe than the present, or not, is not now material. Contemplating the removal of masses of comparatively recent structure like these, of which it is hoped we have proof, it becomes no extravagance to suppose that the chalk of England and Ireland have been united, and that the lias of both these countries and of the west of Scotland† form parts of the same expansion.

The modification of the earth's present surface may by some be considered as a matter of secondary importance, the mode of formation, next to structural arrangement, being with them the greatest point of attraction. There are others who consider it a matter of such inexplicable confusion, as to be out of the reach of a rational theory. To the first it may be answered, that all the parts of a science so hinge upon each other, that the establishment of a truth upon one point cannot but benefit the whole. And to the latter class of objectors we may reply, that the most discordant things in nature, or that are apparently so, have a plan; and that to reason from particulars to generals is, and has been, the means of achieving the greatest victories of the human mind‡.

Here

* It is probable that a very strict examination into this part of the subject would add more than 1000 feet to this computation.

† Geol. Trans. vol. ii. p. 363. New Series.

‡ These may be deemed threadbare truisms; and yet they will be recognised by many who lament that the labours of the last twenty years yet remain

Here is an operation which, singly considered, bespeaks a uniform and simultaneous action along a line of country of 200 miles extent, with a totality so complete, and a harmony of parts so consistent, as to amount to direct proof of unity of cause. But these appearances not only harmonize with each other, and with operations which may be proved to be contemporaneous; they agree also with the universal phænomena of structural derangement. Everywhere we observe protrusion and subsidence, denudation and erosion, going hand in hand. In all parts of the globe we find longitudinal valleys surmounted by scarped extremities, or basset-edges of broken strata; river-courses taking the lines of the original rents of rocks, and intersecting their mountain ranges by transverse valleys to which these fissures have given origin. Does one portion of these broken masses protrude through others,—if it be rocky and indurated, and resist the action of denudation, we see a range of hills, or an "outlier-by-protrusion,"—if it be soft and destructible, we have a "valley of elevation." The loftiest peaks are but the denuded or protruded extremities of fissured masses*, and whole continents only the shattered tops of ridges whose bases are hid beneath the waves.

It is difficult to quit this subject without reverting to the probable, nay, indubitable connection of convulsion with diluvian action. Dislocations as great, as widely extended, and of the same character as these which we contemplate, are everywhere to be met with; and their contemporiety is almost established by their community of character. They can scarcely be regarded in the light with which we are accustomed to view the operations of even volcanic forces, in times

main uncombined in anything like an intelligible and systematic form. The modern sons of the Dædalus of Geology are in little danger of singeing their wings. The exceptions to the general timidity are few, but they encourage a hope that we are not

"Doom'd to dwell in *specialities* for ever;"

and that the work of generalization will not be left, most unpatriotically, to the livelier perceptions of our neighbours, to be caught up and happily codified for general use, and appropriated by any other name than English.

This is not spoken invidiously: the great attainments and greater industry of the French naturalists are beyond all praise. But the spirit of distrust hovers over the councils of English geology. Curiosity is repressed till a violent and injurious reaction is threatened; and for want of better lights, men begin to indulge in speculations as wild as the fancies of Whiston or the conceits of Buffon; or, what is almost as bad, stop short at the last "Theory of the Earth," and believe that to be conclusive.

* Putting out of question here those matters which can be proved to have possessed fluidity at the time of emission.

of

of their greatest activity: and whilst we allow that intervals of long repose were necessary for the operations of deposit and formation, we must also confess that they have given place to paroxysms of perhaps not immeasurable activity.

An act like the elevation of the anticlinal line, which formed the basins of London and Hampshire, or the subsidence of these basins, would be alone sufficient to raise a wave that would drown the habitable parts of half a hemisphere. A few such actions coming into play contemporaneously, or in quick succession, are cause sufficient for a deluge. The sagacity of a living geologist has shown that such a deluge was universal; and a little further research only is sufficient to show, that we need not leave our own planet for secondary causes adequate to the purpose: to show also, that the flood which left us the "Reliquiæ Diluvianæ," was the flood of denudation; and that that flood (denudation being in many cases ruled by disruption and devastation from below) went and came upon the earth many days.

Pulborough, Jan. 1, 1829.

XIX. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 51.]

Genus 38. PSYCHE, *Schrank, (Steph.)*

Canephoræ, Hübn. Bombyx, Fab., Latr.

Legs slender, transparent, scarcely pilose; posterior tarsi with very short spurs at the apex.

Wings in the male elongate, rounded posteriorly, very transparent, slightly hairy; wanting in the females.

Antennæ—of the male rather short, bipectinated, the pectinations twisted and very pilose:—of the female very short, simple, submoniliform, the two basal joints very large and robust, the rest small.

Palpi and *maxillæ* none, replaced by a loose tuft of hair.

Head and *thorax* scarcely pilose, shining: *abdomen* of the male rather robust, thickly pilose;—of the female naked, rather glossy above, with a woolly mass at the apex: *ovipositor* exserted, subtruncate *.

Larva inclosed in a cylindrical case, composed of blades of

* Characters from Stephens. *Illust. Brit. Ent.* II. *Haust.* p. 79.

grass,

grass, morsels of leaves, bark of trees, &c. and which it drags about with it by means of the anterior or *pectoral* feet (hence called sacciferous larvæ), the only ones fit for crawling—the posterior being imperfect.

Pupa elongate: *metamorphosis* in the larva-case attached to the branches of trees, or other elevated objects. Prior to the change the larva is reversed; so that the imago issues from the posterior aperture. (Ochs.)

Obs. The natural history of the sacciferous insects has for many years engaged the attention of the most distinguished entomologists, and yet much still remains to be done for its perfect elucidation, although many singular and important facts have been discovered respecting them. One of the most remarkable is that of the females occasionally laying fruitful eggs without any previous intercourse with the male: the fact is as unquestionable as it is mysterious, having been confirmed by many experiments conducted with every necessary precaution. The most complete are those of Rossi, an account of which is given in a letter on *Psyche apiformis*, addressed to the Abbate Mazzola.

I venture to introduce the genus *Psyche* (which cannot with propriety be arranged with the *Tineæ*, Schaben?) in this place; since, in respect of the perfect male insect, it forms the fittest passage to the next genus (*Liparis*). Ochs.*

A.—Females apterous, hexapodous: *abdomen* terminated by a pilose tuft: *ovipositor* exserted.

Species.	Icon.
1. Ps. *Pulla*, Esp.	Hübn. Tineæ, Tab. I. f. 7. (mas.)
2. — *Plumella*, Ochs.†	Hübn. Samm. auser: Vog. und Schmett. Tab. 47.
3. — *Nitidella*, Hübn..	Hübn. Tineæ, Tab. I. f. 6. (mas.)
4. — *Pectinella*, Fab....	Hübn. Tineæ, Tab. I. f. 5. (mas.)
5. — *Bombycella*, Hübn.	Hübn. Tineæ, Tab. I. f. 4. (mas.)
6. — *Calvella*, Ochs. ...	Hübn. Tineæ, Tab. I. f. 3. (mas.)
7. — *Nudella*, Ochs.‡..	— — — —
8. — *Glabrella*, Ochs...	Hübn. Tineæ, Tab. 31. f. 212. (mas.) Tab. 56. f. 382. (fœm.)
9. — *Politella*, Ochs.§..	— — — —

* Poda in the *Mus. Græc.* places them with *Tenthredo*, and Scopoli, in the *Ento. Carniol.* with *Phryganea.*—*Ochs.*

† Ps. alis rotundatis fuscis, nigro-venosis.—*Ochs.* III. 168.

‡ Ps. alis omnibus albo-cinereis, subhyalinis, albo-ciliatis.—*Ochs.* III.173.

§ *Nov. Sp.* Ps. alis anticis oblongis, lividis, immaculatis; posticis cinereis, ciliis albidis.—*Ochs.* IV. 200.

B.—Fe-

B.—Females vermiform; no visible organs of emotion.

Species.	Icon.
10. Ps. *Hirsutella*, Ochs.*	— — —
11. — *Muscella*, Fab. ...	Hübn. Tineæ, Tab. 2. f. 8. (mas.)
12. — *Plumifera*, Ochs.†	— — —
13. — *Apiformis*, Rossi .	Hübn. Tineæ, Tab. 44. f. 305.
14. — *Viciella*, Fab.	Hübn. Tineæ, Tab. 41. f. 280. (mas.)
15. — *Villosella*, Ochs. .	Hübn. Tineæ, Tab. 1. f. 2. (mas.)
16. — *Graminella*, Hübn.	Hübn. Tineæ, Tab. 1. f. 1. (mas.)

Genus 39. LIPARIS, *Ochs.*

Laria, Schrank. Hypogymnæ et Leucomæ, Hübn.

Antennæ bipectinate, the pectinations in the male very strong.
Maxillæ none.
Wings deflexed, rather lightly scaled, generally of one uniform colour, or marked with dark maculæ or bands.
Abdomen,—in the female often furnished at the apex with a large, finely pilose, tuft, with which she covers her eggs when deposited, tearing it from her body for that purpose, by means of the hinder legs.
Larva with hairy tubercles, variegated.
Pupa with small pilose tufts; changes in a thin web.

Obs. All the species enumerated below, unquestionably belong to this genus; the two last, only, differing from the rest, as regards the pupa and its web; but there does not appear to be sufficient reason for assigning them a separate place on that account. (Ochs.)

Species.	Icon.
1. L. *Morio*, Linn.‡ ...	Ernst, IV. Pl. CXXXIV. f. 179. a—d.
2. — *Detrita*, Esp.‡ ...	Hübn. Bomb. Tab. 16. f. 58. (mas.) 59. (fœm.)
3. — *Rubea*, Fab.‡	Hübn. Bomb. Tab. 56. f. 240. (mas.) Tab. 16. f. 60. 61. (fœm.) §
4. L. *Mo-*	

* Ps. alis nigrescentibus, abdomine hirto, fusco.—*Ochs.* III. 173.

† Ps. alis angustis, hyalinis, corpore atro, hirsuto, antennis plumosis.—*Ochs.* III. 176.

§ 3*P. *nigricans*, Curtis..... Curtis, Brit. Ent. V. Pl. 213.
This species is not noticed by Ochsenheimer.

‡ Penthophera, *Germar, Curtis, Steph.*
" *Antennæ* inserted on the crown of the head close to the eyes, setaceous, strongly bipectinated in the males, each joint producing two slightly clavate rays, very long and slender towards the centre, pilose, and terminated by a few strong hairs; simple in the females. *Maxillæ* none.

Species.	Icon.
4. L. *Monacha*, Linn.*	Ernst, IV. Pl. CXXXVII. f. 185. a—i.
5. — *Dispar*, Linn.† ...	Ernst, IV. Pl. CXXXVIII. f. 186. a—g.
6. — *Salicis*, Linn.‡ ...	Ernst, IV. Pl. CXXXV. f. 181. a—d.
7. — *V. nigrum*, Fab.‡	Ernst, IV. Pl. CXXXIV. f. 180. a—g.

8. L. *Chry-*

Labial palpi cuspidate, nearly concealed by hair, porrected, triarticulate? the basal joint very obscure, 2nd small, 3rd large, oval. *Head* small. *Eyes* small, globose, granulated. *Thorax* large in the males alone. *Abdomen* sometimes short and truncated in the male, subovate in the female. *Wings* large and rounded, rarely small and lanceolate in the female. *Legs* slender. *Tibiæ* anterior with a short slender spine on the internal side, the others spurred only at their apex. *Tarsi* 5-jointed, basal joint the longest, penultimate the smallest. *Claws* and *pulvilli* distinct. *Larva* with 6 pectoral, 8 abdominal, and 2 anal feet, tuberculated, each tubercle producing a bundle of hairs."—*Curtis, Brit. Ent.* V. 213.

* Psilula, Steph.

"*Palpi* very hairy, triarticulate; the basal joint nearly half as long as the second, somewhat clavate; the second elongate, clavate; the terminal ovate, acute: *maxillæ* obsolete. *Antennæ* short, acute, very strongly bipectinated in the males, slightly in the females: *head* small, very pilose: *thorax* rather short and downy: *abdomen* slender, and tufted at the apex in the male, rather short and attenuated in the female, with the apex acute and naked: *wings* deflexed, thickly clothed with scales: *legs* not very slender; *femora* and *tibiæ* fringed with hairs. *Larva* elongate, attenuated posteriorly, with fascicles of hair on the back and sides; those behind the head and on the penultimate segment longest. *Pupa* smooth, with tufts of hair on the segments, the terminal one with an obtuse projection: changes in a loose folliculus."

"This genus differs from the foregoing (*Hypogymna*) by having the basal joint of the palpi elongate, somewhat triangular and clavate, the terminal acute, and closely allied to the preceding; the female has the abdomen moderately stout, and attenuated posteriorly, with the ovipositor exposed."—*Steph. Illust. Brit. Ent.* II. 57.

† Hypogymna, Steph.

"*Palpi* hairy, short, triarticulate, the basal joint minute, second elongate, subclavate, terminal ovate, obtuse: *maxillæ* obsolete. *Antennæ* short, acute at the tip, very strongly bipectinated in the males, slightly in the females: *head* minute, with a downy tuft: *thorax* and *abdomen* stout, woolly, the latter very robust and obtuse in the female, and terminated by a downy mass, rather attenuated, and furnished with a hairy tuft in the male: *wings* deflexed, not very densely clothed with scales: *legs* not very stout; *femora* and *tibiæ* slightly fringed with long hairs. *Larva* elongate, cylindric, with short, rigid hairs on the back, and elongate fascicles on the sides of the head, and at the tail: *pupa* slightly hairy, the apex with a truncate projection: it changes in a loose cocoon."—*Steph. Illust. Brit. Ent.* II. 55.

‡ Leucoma, Steph.

"*Palpi* short, bent upwards, hairy, cylindric, triarticulate, the intermediate joint

Species.	Icon.
8. L. *Chrysorrhœa*, Linn.*	Ernst, IV. Pl. CXXXV. f. 182. a—f.
9. — *Auriflua*, Fab.*...	Ernst, IV. Pl. CXXXVI. f. 183. a—f.

joint longest, the terminal shortest, obtuse: *maxillæ* very short. *Antennæ* acute, of equal length in both sexes, deeply bipectinated in the males, the *pectinations* gradually shortened towards the apex, ciliated and furnished with one or two fine setæ at the tip, shortest in the females: *head* small, hairy, with a distinct fascicle of scales at the base of each antenna: *thorax* short, woolly: *abdomen* tufted in the males, very robust and acute in the females: *wings* deflexed, rather broad, trigonate, with remote scales: *legs* robust; *femora* and *tibiæ* slightly fringed with hair. *Larva* with fascicles of hair on each side, and sometimes with loose dorsal tufts: *pupa* slightly hairy, enclosed in a loose orbiculate cocoon: *eggs* enveloped in a friable silken matter."—*Steph. l. c.* p. 63.

* Porthesia, Steph.

"*Palpi* very short, descending, slightly hairy, cylindric, triarticulate, the terminal joint exposed; the basal minute, about half as long as the terminal, the intermediate longest: *maxillæ* very short: *antennæ* short, especially in the females, acute, bipectinated in both sexes to the apex, the pectinations shortest in the females: *head* small, very pilose: *thorax* and *abdomen* somewhat robust and woolly: *wings* deflexed, subtrigonate, thickly clothed with scales: *legs* robust, short; *femora*, *tibiæ*, and *anterior tarsi* densely fringed with elongate hairs. *Larva* with close fascicles of hair down the sides, rather longest on the neck; the back without tufts: *pupa* slightly hairy, acute, enclosed in a slight folliculus: *eggs* enveloped in down."—*Steph. Illust. Brit. Ent.* II. 65.

Schrank's genus *Arctia* is quoted by Ochsenheimer as forming part of his genus *Eyprepia*. Curtis has adopted the genus *Arctia*, as Stephens has also done more lately; the former inserting under it the British species, 1. *cœnosa*, Hübn.; 2. *V. nigra*, Fab.; 3. *Salicis*, Linn.; 4. *chrysorrhœa*, Linn.; and 5. *phœorrhœa*, Haw. The first and last species I cannot find noticed at all by Ochsenheimer; the second, third, and fourth, form part of his genus *Liparis* (q. v. *ut sup.*). Stephens has adopted Hübner's genus *Leucoma* to receive *V. nigra* and *Salicis*; and has created a new one, *Porthesia*, for *chrysorrhœa* and another; and his genus *Arctia* consists of *Caja*, *matronula*, *villica*, *Hebe*, *purpurea*, and *aulica*, all of them *Eyprepiæ* of Ochsenheimer. He has, moreover, created another new genus, *Lælia*, to receive Hübner's *Bombyx cœnosa*, and which he characterizes as follows:

"LÆLIA, *Steph.*

"*Palpi* elongate, projecting, very hairy beneath, the last joint exposed; triarticulate, the basal and terminal joints very minute, the second considerably elongated: *maxillæ* distinct. *Antennæ* moderate, shortest in the females, deeply bipectinated in the males the pectinations terminating abruptly at the tip, and very short in the female, each pectination ciliated, and furnished at its apex with three or four divergent bristles: *head* small, pilose; *thorax* not crested, pilose: *wings* deflexed, rather narrow, trigonate, sparingly clothed with scales: *abdomen* rather elongated, and stout, slightly tufted: *legs* moderate; the *femora* and *tibiæ* fringed with elongate hairs. *Larva* hairy, with four compact dorsal tufts, and one at the tail, and two elongate fascicles at the neck: *pupa* slightly pilose, acute at the tip, enclosed in an elongate, compact, yellow folliculus."

1. Læ. *Cœnosa*, Hubn.....	Curtis, Brit. Ent. II. Pl. 68. ♂, ♀ and Larva.

Genus 40. ORGYIA, *Ochs.*

Laria, Schrank. Dasychiræ, Hübn.

Legs, anterior hairy, stretched out forwards, when at rest*.
Antennæ,—in the male strongly bipectinate; in the female only slightly feathered.
Haustellum very short.
Wings deflexed.
Larva, with hairy tufts on the head, back and posterior portions of the body.
Pupa hairy; the metamorphosis takes place in a double web mixed with hairs†.

Species.	Icon.
1. O. *Pudibunda*, Linn.‡	Ernst, IV. Pl. CLX. f. 207. a—g.
2. — *Abietis*, Hübn. ...	Hübn. Bomb. Tab. 21. f. 82. (mas.) 83. (fœm.)
3. — *Fascelina*, Linn. ‡	Ernst, IV. Pl. CLXI. f. 209. a—h.

* Hence the name of the genus, from ορεγω, *extendo*, and γυιον, *membrum*.

† Stephens has adopted Ochsenheimer's genus *Orgyia*, for his two last species, *Gonostigma*, and *Antiqua*, with the following characters:
" *Palpi* short, compact, hairy, biarticulate; the basal joint small, the terminal large, broad, ovate, subacute: *maxillæ* obsolete. *Antennæ* short, deeply bipectinated in the males, abruptly terminated: serrated in the females, each serrature producing a bristle: *head* small, hairy: *thorax* slender, not crested: *wings* deflexed, short, triangular, or wanting: *legs* rather stout, anterior elongated; the *femora* and *tibiæ* of all, and the *tarsi* of the anterior, fringed with elongate hairs. *Larva* with distinct fascicles of hair on the sides, and several dorsal tufts; two or more, composed of capitate hairs, on the sides of the body and head; one on the penultimate joint, and some shorter ones at the apex: *pupa* slightly pilose, with an acute spine at the tip: *folliculus* ovate, of a very loose texture."—*Illust. Brit. Ent. Haust.* II. 60.
The females of this genus are apterous.

‡ Dasychira, Hübn. Steph.
" *Palpi* very short, hairy, triarticulate; the basal joint about one-third the length of the second, and more slender, the terminal ovate, acute: *maxilla* obsolete. *Antennæ* short, acute at the apex, thickly bipectinated, especially in the male; the pectinations deeply ciliated, and shortest in the females: *head* small, hairy: *thorax* rather stout, not crested: *abdomen* somewhat robust, especially in the females, woolly beneath: *wings* deflexed, elongate, thickly and densely covered with scales: *legs* short, stout, pilose; *femora* and *tibiæ*, and *exterior tarsi* fringed with long hairs. *Larva* very hairy, with several compact, truncated tufts on the back, and another on the tail: *pupa* hairy, enclosed in an ovate folliculus, its posterior extremity with an acute projection."—*Steph. Illust. Brit. Ent. Haust.* II. 58.
Dasychira, Stephens adds, differs " from *Orgyia*, by the acuteness of the apex of the antennæ, and triarticulate palpi. The species of this genus considerably resemble those of *Cnethocampa*."—(*Gastropacha*, Ochs.) *Steph.* l. c.

4. O. *Sele-*

Species.	Icon.
4. O. *Selenitica*, Hübn.	Hübn. Beitr. II. B. 3. Th. I. Taf. fig. A. (fœm.) Hübn. Bomb. Tab. 20. f. 79. (mas.) 80. (fœm.)
5. — *Gonostigma*, Fab.*	Ernst, IV. Pl. CLXIII. f. 212. a—h.
6. — *Antiqua*, Linn.*..	Ernst, IV. Pl. CLXII. f. 211. a—f.

Genus 41. PYGÆRA, *Ochs.*

LARIA, Schrank. PYGÆRA, Steph.
MELALOPHÆ, Hübn. CLOSTERA, Hoffmansegg, Steph.

Antennæ bipectinate.
Haustellum short.
Wings lie close to the body; anterior with a coloured spot at the apex, and bright curved transverse lines.
Head and *thorax* with a velvety striga.
Abdomen long, tufted at the extremity (tuft bifid in the male); posterior portion elevated when at rest †.
Legs, anterior extended.
Larva slightly pilose; with a hairy tubercle on the fourth and last segment.
Pupa, with the extremity aculeated, changes in a close web, enveloped in leaves.
Obs. Ochsenheimer confesses that it is difficult to justify the placing the sixth species (*Bucephala*) with the rest of his *Pygæræ*, since the setose antennæ of the females, the fore feet extended when at rest, and the mode of metamorphosis, are opposed to that arrangement. He has consequently separated that species and the next (*Bucephaloides*) from the five preceding, under a third family of the genus C. Stephens places *Bucephala* alone in the genus *Pygæra*, though his generic characters differ little from those of Ochsenheimer, as far as the latter go. Four other species of our author's *Pygæræ* (composing his family B. of this genus) are placed by Stephens in Hoffmansegg's genus *Clostera*, which he adopts, as will be seen presently. To the preceding generic characters of Ochsenheimer, I add, in a note hereafter, those of *Pygæra* as given by Stephens: the characters of the genus *Clotexa* will also be found below.

* Genus, ORGYIA, Steph.
† Hence the name of the genus, from πυγη, *anus*, and αιρω, *tollo*.

Species.	Icon.
Fam. A. 1. *Py. Timon*, Hübn.	Hübn. Bomb. Tab. 22. f. 86. (mas.)
Fam. B. 2. *Anastomosis*, Linn.*	Ernst, IV. Pl. CLXIV. f. 213. a—i.
3. Py. *Reclusa*, Fab.*...	Ernst, IV. Pl. CLXV. f. 216. a—e.
4. — *Anachoreta*, Fab.*	Ernst, IV. Pl. CLXV. f. 214. a—e.
5. — *Curtula*, Linn.*...	Ernst, IV. Pl. CLXV. f. 215. a—c.
Fam. C. 6. *Bucephala*, Linn.†	Ernst, V. Pl. CLXXXV. f. 240. a—h.
6. Py. *Bucephaloides*, Ochs.	Hübn. Bomb. Tab. 63. f. 267. (mas.) 268. (fœm.)

* Clostera, Hoffmansegg. Steph.

"*Palpi* short, porrect, slightly ascending and pilose, triarticulate, the apical joint minute. *Antennæ* short, curved, pectinated to the apex in both sexes, in the males especially, with a fascicle of scales at the base: *head* very minute, concealed beneath the *thorax*, the latter robust, strongly crested, with a central, coloured, longitudinal patch: abdomen moderate, the apex suddenly attenuated, with a bifid tuft: *wings*, *anterior* elongate, the hinder margin entire, the apex with a more or less discoloured patch; *posterior* entire; *tibiæ* with spurs. *Larvæ* slightly pilose, with a tubercle on the fourth, and another on the anal segment, posterior legs perfect: *pupa* folliculated."—*Steph. Illust. Brit. Ent. Haustell.* II. p. 12.

The distinguishing characters between this genus and *Pygæra*, Stephens states to be the brevity of the antennæ of the former, which are pectinated in both sexes and distinctly curved; the form of the thoracic crest, and the longitudinal patch thereon; the deeply inserted, minute head, and the integrity of the posterior margin of the anterior wings. The larva differs from that of *Pygæra* in being very slightly pilose, and in having the fourth and anal segment, tuberculated above.—*Steph.* l. c.

† Pygæra, Steph.

"*Palpi* short, porrect, densely pilose, two-jointed, basal joint incurved, second reversed, obtuse. *Antennæ* rather long, pectinated in the male, each articulation producing a duplex cilia on each side, the apex simple; setaceous in the female; *head* small, with a bifid crest at the base of the antennæ: *thorax* stout, strongly crested, with two elevated lateral strigæ: *abdomen* long, the apex with an undivided tuft: *wings*, *anterior* elongate, triangular, the apex with a large, rounded, discoloured patch, the hinder margin denticulated; *posterior* entire: *tibiæ* with spurs. *Larva* cylindric, pilose, without elevated appendages, the anal legs perfect: *pupa* subterranean."—*Steph. Illust. Brit. Ent. Haustellata*, II. p. 11.

[To be continued.]

XX. *Notices*

XX. *Notices respecting New Books.*

The Amateur's Perspective; being an attempt to present the Theory in the simplest form; and so to methodize and arrange the subject, as to render the Practice familiarly intelligible to the uninitiated, in a few hours of study. By Richard Davenport, Esq. London, 1828; 4to. pp. 84. Fourteen Lithographs.

THE following extracts from the Preface to this excellent work, with the table of Contents subjoined, will convey a better idea of its nature and utility than any account of it which we could draw up.

"It cannot but be a matter of surprise, that in a confined branch or department of geometry, there should be much variety of system; that the teaching of Perspective, which is purely geometrical, should not, long ago, have been reduced to a concise and generally adopted method, and that systems and treatises should have succeeded each other for centuries, and books on the subject should still be multiplying.

"The Author of the present treatise must therefore apologize for adding another to the heap; and his apology is this: viz. that having looked into most that have been mentioned to him, both of old and modern treatises, including three Encyclopædias, he has not found one that combines all the requisites he deems essential. Some he has found (to himself at least) absolutely unintelligible. Some, involving most unnecessary intricacies. Some, omitting links in the chain of progressive instruction, leaving the scholar in difficulties which can be remedied only by reference to other treatises, or by requiring the assistance of masters; and in general, the rules and problems given without the *rationale* of the system, or demonstration of the correctness of the solutions, for want of which they appear to the scholar as so many arbitrary rules, which frighten him at the outset by their apparent perplexity, and escape from his memory afterwards."

"In the following, it will be found that the Author has made an attempt to simplify the theory, and show how the visible lines directed to be drawn within the picture, do represent the imaginary lines defined in the system. This part may be studied by those who find it interesting. It will certainly facilitate their knowledge of the practical part, enabling them not only more readily to comprehend and remember the rules, but to apply them universally. Those who would save themselves the trouble of studying the theory, and wish only for a present rule to perform a present operation in practice, may omit it; and it is hoped that they will find what they want in its proper place in the practical part of the work."

"Some persons object to the study of Perspective, thinking that it confines genius, gives a stiffness of execution, and tends to produce such pictures only, as, if mathematically correct, are yet unpleasing and uninteresting.

"It is possible that persons, of whose education it has formed a part, may have been so long accustomed to straight lines, that their eye requires them, and their hands habitually form them; but such effect

effect is by no means the necessary consequence of the study of correct Perspective. It is probable that the objectors are prejudiced by the unpleasing appearance of the illustrations in books of Perspective; but they should consider them as illustrations only, not as examples. In these illustrations generally the horizon-line is made higher, and the line of distance shorter, than the designer of them recommends in his book; but this is purposely done for the sake of making plain the thing taught, *i. e.* making it more *visible*; for if diagrams were pictures, the parts described would be too minute and crowded, to be intelligible.

" Again; diagrams must necessarily be described by actual lines. There are no actual lines in nature, therefore the diagram is displeasing: besides, (and this is an important ingredient of the difference between a diagram and a picture,) visible lines have actual thickness and intensity; and the same must necessarily be extended to the distance represented; whereas that thickness and intensity ought to vanish in the true perspective distance. The disgust therefore arises from the diagram (the representative of the picture), not the picture drawn according to its rules.

" But some objectors say, ' If one draws what he sees, is not that enough; why study rules?' We answer, it *is* enough. It is all that is wanted, *if* one draws what he sees: but the rules are given to *enable* him to ' draw what he sees.' But he never saw a man standing on the same level with himself, and a mountain or a cottage, or even another man brought by the distance below his elbow, or even shoulder. How often do we see it in pictures? He never saw the great window in front of a cathedral directly, or nearly directly, facing him, and the side of the structure at the same time: but many a drawing exhibits them so. He never saw the head or the stern of a boat and its side in profile at the same time. Half the number of boats on paper (not to say canvass,) are so represented.

" There is a large and voluminous work containing fifty and more fine views of the antiquities and ruins of Rome and its environs. The spectator will there see ranges of columns receding from the eye, equally distant one from the other in the original, and equally distant one from the other in the picture. The like absurdities run through the work; and whether the artist is so ignorant of Perspective as to think he has ' drawn what he has seen,' or has affected a slovenly contempt of rules, the worth of his work is annihilated.

" Even small objects put in the foreground of a sketch, insignificant of themselves, if out of perspective, destroy the levels, and put the rest of the sketch, as it were, awry: and though some persons have a naturally correct and accurate eye, and will describe ' what they see ' rightly without study or instruction, such instances are rare; and it is worth while to those who draw for amusement, to gain the little knowledge requisite for their purpose."

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Chapter 2. *Problems.*—To find the Perspective of Points on the Ground Plane;—Perspective of a line oblique to Plane of Picture;—Of a Line perpendicular to same;—Parallel;—Perspective of Triangles;—Of Parallelograms;—Perspective of Divisions of Lines, equal or proportional;—Perspective of Curves;—Of Circles;—Curvilinear Lines generally;—Volutes and Spirals;—Inscriptions;—For finding Perspectives without inversion of original;—Of the general bearings of Squares and Parallelograms, with their Diagonals.

Chapter 3. Of *Solids.*—Right-angled Quadrangular Structures;—Their Faces and Sides with symmetrical Breaks and Divisions;—Of *Planes* oblique to Horizon Planes;—Elevations on Circular Planes (as Columns, &c.);—Paradoxical appearance of equal Circles and Cylinders; those at the sides larger than the central;—In Perspective, diameter not the longest Line;—Sections of Solids, horizontal;—Vertical;—Relative Magnitudes and Heights of Objects.

Chapter 4. Summary, and additional Remarks;—Various methods of dividing Surfaces; by Diagonals;—By proportional Triangle;—Scale for Division extended beyond the Picture;—Contrivance for Ruling or Proving a multitude of Lines vanishing together;—Shorter Method of putting Circles in Perspective;—Geometrical Plan for Circles of all sizes;—Of Mechanical Instruments;—Camera-Lucida;—Divided Frame for choosing a view;—Further consideration of Horizon-line,—Point of distance,—Field of Vision,—Necessity of placing the Zero Point in centre of Picture,—Perspective of very high Vertical Lines and Spaces,—Difficulty of Down-hill Views, and of Levels much below the Eye,—postponed. Conclusion.

XXI. *Proceedings of Learned Societies.*

ROYAL SOCIETY*.

June 5, 1828. "ON the laws of the deviation of magnetized needles towards iron," by S. H. Christie, Esq. M.A. F.R.S. &c.

The author had pointed out, several years ago, the law of deviation of a magnetized needle, (either freely suspended, or constrained to move in any particular plane,) from its natural position, by the influence of masses of iron in its vicinity. This law was founded on the hypothesis, that the iron *attracted* both the poles of the needle; the position of which, resulting from this action, might be determined by that of an imaginary minute magnetic needle, freely suspended by its centre of gravity, reduced to the plane of revolution. The author had considered this law as fully established, from its accordance with experiment: but Mr. Barlow, in a paper which was published in the last volume of the Philosophical Transactions, denies that such an accordance exists, and infers from the results of some experiments which he made on horizontal needles having their magnetism unequally distributed in their two branches, that the theory on which the preceding law is founded is fallacious. In opposition to the views of

* The portion of the proceedings of the Royal Society here given, consists of abstracts of the papers read at the meetings at the end of the session 1827-8.

Mr. Barlow, the author contends that the phænomena observed are precisely those which must result from the theory he had himself adopted; and that they tend in no way to support the hypothesis of their being simply the effects of the magnetic power which the iron receives by induction from the earth.

The author was also led to suspect the accuracy of another conclusion which had been drawn by Mr. Barlow, namely, that the length of the needle has no sensible influence upon the extent of its deviations. In order to determine this point, he began by ascertaining more scrupulously than had yet been done, the values of several of the elements of the calculation, such as the exact positions of the points where the intensity of the magnetism is the greatest, and also of the point of neutrality, or of the magnetic centre: and he next subjected to a more severe scrutiny a law which had been regarded as established by experiment; namely, that the tangent of the deviation is proportional to the rectangle of the cosine of the longitude, into the sine of the double latitude of the position of the centre of the needle with relation to the mass of iron as referred to a hollow sphere.

In the course of his experiments the author ascertained that if any bar of steel uniformly magnetized by the method of double touch have this state of magnetism disturbed by drawing the end of a magnet from its centre to the end, having the same polarity as that applied to it, then the pole at that end will be shifted towards the centre; while the opposite pole will be removed further from it: and a corresponding change will occur in the position of the magnetic centre. Changes will also take place in the absolute intensities of the magnetism at each pole. Considerable differences were observed in the extent of the deviations of a needle six inches in length, and of one of two inches long, when successively placed in the same position with relation to the shell of iron. At the distance of 16·8 inches, they amounted to more than two degrees and a half; and the difference continued to be very sensible, even at a distance of 24 inches from the shell. In general, when the needles were near to the north or south of the centre of the shell, the deviations of the longer needle exceeded those of the shorter; and the reverse took place when the needles were placed on the east and west sides. Hence he concludes, that the efficacy of a small mass of iron placed near to the needle to serve as a compensation to the effects of more distant masses, will depend upon its being itself at such a distance from the needle as that the difference of its action upon a long and a short needle shall be insensible.

The author proceeds to deduce from the law which he has proposed, various forms of equations for determining the deviations of a horizontal needle due to the action of an iron sphere or shell, applicable to different circumstances and conditions of the case. In one set of equations, the actions and resulting positions are referred to three rectangular co-ordinates proceeding from the centre of the needle; and in another set, they are referred to polar co-ordinates, relative to the vertical and to the plane of the horizon. He next deduces equations for computing the deviations of a needle in which the magnetism has been disturbed, by applying to one of its poles the corresponding

corresponding pole of a magnet. He then proceeds to the detail of experiments for investigating the above-mentioned laws; and to their comparison with the results deduced from theory. These experiments appear to him to establish beyond all doubt the influence which the length of a needle has on its deviations produced by the attraction of the shell of iron. When examined by the test of the formulæ given by the author, the law of the tangent of the deviation being proportional to the rectangle of the cosine of the longitude into the sine of the double latitude, on which so much dependence had been placed, is found to give results so inconsistent with one another, that it cannot be considered as even affording an approximation to the truth, and must therefore be wholly rejected.

The close agreement which the author found between the observed and the computed deviations of needles whose magnetism had been disturbed by contact with a magnet, as well as those which had suffered no disturbance, fully confirmed him in the views which he originally took of the action of iron on magnetized needles. He conceives that his hypothesis, instead of being at variance with observation, is not only consistent with all the experiments that have been made, but by affording the proper corrections to be applied to them, derives the strongest support from these observations.

He concludes by mentioning a fact which he conceives to be irreconcileable with the hypothesis of induced magnetism; namely, that a steel bar rendered as hard as it was possible to make it, produced, when its ends were reversed, precisely the same effect on the needle as a bar of the softest iron under similar circumstances.

June 12.—"An account of a series of experiments on the friction and resistance of fluid and solid bodies retarded by the attrition of their surfaces when rubbing against each other," by George Rennie, Esq. F.R.S.

The first part of this paper is occupied by a rapid review of the labours of mechanicians on the subject of friction, from the period of those of Amontons, at the end of the 17th century, to those of Coulomb and of Vince, in the years 1779 and 1784; from which the author draws the conclusion, that the progress of knowledge in this department of science has been slow and unsatisfactory; and that a wide field is still left open to experimental investigation. With a view to elucidate several points not yet sufficiently ascertained by former writers, the author instituted several sets of experiments; some calculated to determine the forces required for dragging bodies of various kinds along a horizontal surface, and others for measuring the angle at which a plane was required to be inclined to the horizon, in order to admit of the body sliding down it: attention being paid to the circumstances of pressure, extent of surface, time of previous contact, and velocity of motion.

The following are the principal conclusions which the author deduces from his experiment:

The friction of ice rubbing upon ice diminishes with an increase of weight, but without observing any regular law of increase. When dry leather was made to move along a plate of cast-iron, the resistance

is but little influenced by the extent of surface. With fibrous substances, such as cloth, the friction diminishes by an increase of pressure, but is greatly increased by the surfaces remaining for a certain time in contact: it is greater, *cæteris paribus*, with fine than with coarse cloths: the resistance is also much increased by an increase of surface. With regard to the friction of different woods against each other, great diversity and irregularity prevail in the results obtained: in general, the soft woods give more resistance than the hard woods: thus, yellow deal affords the greatest, and red teak the least friction. The friction of different metals also varies principally according to their respective hardness; the soft metals producing greater friction, under similar circumstances, than those which are hard. Within the limits of abrasion, however, the amount of friction is nearly the same in all the metals, and may in general be estimated at one-sixth of the pressure. The power which unguents have in diminishing friction, varies according to the kind and the fluidity of the particular unguent employed, and to the pressure applied.

The paper is accompanied with drawings of the apparatus used; and the details of the experiments are given at length in a tabular form.

June 19.—"On magnetic influence in the solar rays," by S. H. Christie, Esq. M.A., F.R.S., &c.

From the experiments described by the author in a former paper, it appeared that a magnetized needle vibrated under exposure to the sun's rays, came to rest sooner than when screened from their influence: that a similar effect was produced on a needle of glass or of copper; but that the effect on the magnetized needle greatly exceeded that upon either of the others. In the prosecution of this inquiry, the author has endeavoured to vary the experiments, so as to obviate several causes of inaccuracy, which might tend to invalidate the general conclusions he had before drawn. His first object was to compare the effects of the solar rays on an unmagnetized steel needle with one that was magnetized under the same circumstances; and the result was, that the latter was influenced in a more considerable degree than the former: and a similar difference was observed when the vibrations of a magnetized needle were compared with those of a needle made of glass or of copper. He ascertained that the diminution of the terminal arc of vibration on exposure to the sun, was not occasioned merely by the heat imparted to the needles or surrounding medium, although their cause appeared, in some instances, to measure the intensity of the action which produced the diminution. In order to determine the comparative influence of the separate rays, he allowed them to fall on the needles after transmission, through differently coloured fluids and glasses; but owing to want of opportunity, he was obliged to abandon the inquiry before arriving at any determinate results; though, as far as they went, they appeared to confirm the conclusion, that the effects were dependent on the degree of light, and not on that of the heat. The red rays, however, appeared to have a greater effect in diminishing the terminal arc than the

the blue. In order to determine the simple effect of temperature, independently of light, the needles were vibrated in close vessels, surrounded with water of different temperatures: the results showed that the terminal arc was increased in air of higher temperatures, which is the reverse of what takes place from the direct influence of the solar rays; and that this effect, instead of being different in the magnetized and in the other needle, was nearly the same in all needles, of whatever materials they consisted, and whether magnetized or not.

The author next endeavoured to ascertain the effects produced on the arcs of vibration by the action of a common fire: these, though much less in degree, he found to be similar in kind to those of the sun.

June 19.—"Observations on the functions of the intestinal canal and liver of the human fœtus," by Robert Lee, M.D., Physician to the British Lying-in Hospital. Communicated by Dr. Prout, F.R.S.

From the circumstances of the early development of the liver and intestines of the fœtus, of the copious supply of blood which they receive, and of the great space which they occupy in the abdomen, the author was led to the conclusion, that they performed some important functions in the fœtal œconomy. Although no nutritive matter can be furnished by the mouth, yet the contents of different portions of the alimentary canal were found, both in appearance and chemical composition, to bear a striking analogy to those of the same parts of the canal in the adult, where the processes of assimilation and absorption are performed. A semi-fluid matter possessing all the characters of albumen is found closely adhering to the inner coats of the small intestine; and is more especially abundant around the papillary projection, through which the common duct of the liver opens into the duodenum; and diminishes in quantity, as we trace it towards the termination of the ileum. The great intestines are generally distended with a dark green homogeneous fluid, containing no albumen, and apparently excrementitious. No albumen can be detected in the contents of the stomach. Hence the author infers that an absorption of some nutritious substance, which he brings forward several arguments to show must be derived from the liver, takes place from the intestinal canal in the latter months of gestation. He states, that in two instances he detected the presence of a substance, similar to that which he had found in the duodenum, in the hepatic duct itself. Hence he is led to the conclusion that the function of the liver in the fœtus is not confined to the separation of excrementitious matter from the blood, but that it supplies materials subservient to nutrition. That the substances existing in the intestines of the fœtus are not derived from the mouth, is proved by their being equally found in acephalous children, or where the œsophagus was impervious, as where no such malconformation had existed.

A note is subjoined to this paper by Dr. Prout, giving an account of the mode by which he ascertained the chemical character of the substance referred to his examination: and the paper is accompanied by drawings of the intestinal tube in the fœtus.

GEOLOGICAL

GEOLOGICAL SOCIETY.

November 7.—The Society having assembled this evening for the session :—The reading of a paper "On the Geology of Nice," by H. T. De la Beche, Esq. F.R.S. L.S. & G.S. was begun.

Nov. 21.—The reading of Mr. De la Beche's paper "On the Geology of Nice" was concluded.

The author after describing the situation of Nice, enters into a detailed account of the diluvium and the strata in its neighbourhood.

I.—The diluvium (if indeed it can be so considered) is peculiar; in general it takes the form of breccia, either diffused irregularly or occupying clefts : appearing however in both situations to be intimately connected.

1. Most of the diffused fragments correspond mineralogically with the rocks on which they rest; some few are rounded, and seem to have been transported from a distance. The cement varies in hardness and colour with the substratum. Where the breccia reposes on dolomite or light-coloured limestone, it is so hard as to be blasted by gunpowder, is reddish and vesicular; the vesicles being lined with calcareous crystals.—Where it rests upon gray secondary limestone, or on any of the tertiary beds, it is soft, friable, and almost white. Between Ville-franche and Hospice, the substratum is a sand full of shells so like those of the Mediterranean as to have been called *sub-fossil:* some of these shells retain traces of their native colour, the rest are bleached. This sand-bed at Ville-franche is ten feet at least above the sea : at Baussi Raussi, where it descends to that level, the breccia exhibits pebbles of serpentine as well as limestone :—the limestone pebbles perforated with lithodomi, and the cement containing sub-fossil shells. None of these breccias contain bones.

2. The other variety of the diluvium is lodged in fissures. A vein on the south-east of the Castle Hill has its northern side perforated by lithodomi, and yields two different kinds of pebbles in the blue limestone of the lower part, and the magnesian above; this spot, therefore, affords evidence of four distinct epochs.—1. When the sea higher than at present, introduced lithodomi into the fissure.—2. When the lower part of the fissure was filled with pebbles transported from a distance.—3. When its upper part was filled with the broken bones of animals, shells terrestrial and marine, and with fragments, principally but not solely, of contiguous rocks.—4. When the sea attained its present level.

If any one doubt the diluvial origin of these breccias, because their pebbles have been derived principally from contiguous rocks, intermixed however with a few brought from a distance; let him recollect the diluvium of Lyme and Sidmouth, where the flints unbroken and unrounded seem rather to have been disengaged from the surrounding chalk, than transported from any greater distance by an abrading torrent.

The fossils under the breccia seem to have been quietly deposited by a sea that stood several feet higher than the present Mediterranean. To explain this difficulty, some authors imagine that the Mediterranean has sunk, by forcing its passage through the Straits of Gibraltar;

Gibraltar; but this supposition the author conceives to be improbable.

II. Tertiary rocks consisting of sand, sandstone, and a conglomerate of various rolled pebbles, shell marl, calcareous gritstone and breccia, and gray marl, occupy an extensive area on the west and north-west of Nice.

The shell marl here mentioned is that which Brocchi has described; and it contains in the Sub-Alps the same fossils as in the Sub-Appenines.

In the calcareous breccia are angular pieces of the contiguous limestone and dolomite perforated by lithodomi; adhering to which are sometimes found the lower valves of spondyli, quite perfect, notwithstanding the delicate texture of their edges. The cement contains three species of pecten;—with remains, perhaps, of a Saurian. Care must be taken not to confound this latter breccia, which rises more than a thousand feet above the sea, with the diluvial breccia above described.

On reviewing the tertiary beds, the author remarks in their history three distinct epochs; viz. two of repose, and one of violent disturbance.

2. The Secondary rocks of Nice consist of two great formations; the upper one composed of siliceous, argillaceous, and calcareous particles intimately mixed, but in very variable proportions; some of the beds abounding in green grains; which circumstance, together with the nature of their fossils, induces the author to rank the formation to which they belong with the greensand of England. Nummulites, however, which are rarely found in the greensand of this country, are found plentifully in that of Nice*. The strata are very much disturbed and contorted; so that an unguarded observer might often suppose them to be inferior to rocks on which they are in reality incumbent.

The greensand is succeeded by a lower formation, which the author refers to the Jura-limestone or oolite. In this he has found, occasionally, terebratulæ; in addition to which, it is said by Mr. Allan to contain ammonites, pectens, an echinus, and, near the lighthouse at St. Hospice, numerous corals. In mineralogical character, this stratum is very unlike the English rocks which it is supposed to represent, its principal members being compact limestone, with occasionally, flint, dolomite, and gypsum. The dolomite and compact limestone are intimately connected; but the connection of these two beds with the gypsum is less evident. At Sospello the gypsum affords numerous small crystals of carbonate of magnesia or dolomite; but both these substances are found in too many formations to be considered as characteristic.

The compact limestone, dolomite and gypsum of Nice are most analogous to those of the Tyrol, Carinthia, Stiria, and the North of Italy; in regard to the history of which, M. Von Buch has supposed that what is now dolomite, was not so in the first instance; and that the magnesia contained in it has been absorbed from pyroxenic lava, by the forcible intrusion of which both this and the contiguous rocks

* See Phil. Mag. and Annals, N. S. vol. iv. p. 235.

have

have been elevated, dislocated and contorted. The author assents to this theory; and as the phænomena of the tract described by M. Von Buch agree with those of the tract described by himself, he ascribes the interchange of magnesian and non-magnesian limestones, and the violent disturbances which both have undergone in the vicinity of Nice, to the same cause which M. Von Buch adduces, viz. the proximity of pyroxenic lava. The trap-rocks have not been observed very near Nice: there may be such, however, within a short distance in depth; and the probability that there are, is strengthened by the prevalence of rocks of this class in the mountains of S. Troper and l'Estrelles, and the frequency of pebbles both of trap and porphyry in the tertiary conglomerates above described.

The occurrence of dolomite and gypsum in what the author considers as the oolite formation, and the impracticability of recognizing in this formation near Nice any of the individual beds of which it is composed in England, are new proofs of the danger of judging of large tracts of country by rules derived from the study of detached specimens.—The same stratum, in different parts of Europe, assumes very different appearances; and extreme nicety of discrimination injudiciously applied, is more apt to mislead the geologist than to instruct him.

Dec. 5.—The reading of a paper "On the Excavation of Valleys, as illustrated by the Volcanic Rocks of Central France," by Charles Lyell, Esq. V.P.G.S. F.R.S. &c. and R. I. Murchison, Esq. For. Sec. G.S. F.R.S. &c. was begun.

Dec. 16.— Messrs. Lyell and Murchison's paper, begun at the former Meeting, was concluded.

The theory, long since enounced, which ascribes the excavation of valleys to the long-continued erosion of streams, has been supposed to derive remarkable support from the appearances of the volcanic tracts in the interior of France; and the authors, referring especially to the works of M. De Monlosier, and the illustrations of that district recently published by Mr. Scrope, conceive that what they had seen themselves in Auvergne and the Vivarrais, strongly confirms the views of these and other preceding writers.

1. In the commencement of this paper, several peculiarities are stated in the original form of the lava-currents, or "cheires," of Auvergne; which, if overlooked, might lead to an exaggerated estimate of the quantity of matter removed by the action of rivers. The abruptness, especially, of the lateral termination of many of these currents, is very remarkable, even where the lavas flowed in open spaces, and where the surface has remained entire and apparently unaltered since the time of their consolidation. But the authors still conceive that the waste exclusively attributable to running water and its detritus in Central France, must in the course of ages have exerted a most powerful influence on the external form of the country.

2. In the new Valley, about 250 feet in depth, opened at the Etang de Fung by the waters of the Sioule, after the stream had been diverted from its course by the lava of Come, the matter removed, and still continually carried away by the river, consists of alluvial clay and sand,—and in some cases of the subjacent gneiss, thus excavated

cavated to the depth of 40 feet. It is inferred that no general inundation contributed to this effect, from the total absence of sand, mud, or pebbles, on the surface of the lava of Come; although that current has occupied a low and exposed situation ever since the period when the Sioule began to open for itself its present channel.

3. Near the volcano of Chaluzet, the Sioule has not only cut through more than 100 feet of compact basalt, but also the gneiss beneath, to the depth of at least 50 feet; the ancient channel of the river being marked by a bed of pebbles, intervening between the gneiss and the basalt, and now at a considerable height above the actual stream. And here the authors discovered an ancient mining gallery, driven in horizontally between the basalt and gneiss, so as to exhibit the pebble bed to the distance of 50 or 60 feet; a proof that this deposit was a true river alluvion, and not merely an external accumulation of debris covering superficially a mountain slope. The state of the cone and lava of Chaluzet demonstrates further, that no flood has passed over the country since the commencement of the excavation; and similar inferences are drawn from the condition of the cone of Montpezat in the Vivarrais. At Thueyts, in the same tract, the gneiss is worn into by the Ardêche, in one instance to 70 feet below an ancient alluvion overlaid by basalt. And in this valley an undulating band of pitchstone, at right angles to the vertical columns, occurs between the prismatic basalt and the subjacent gneiss, affording an exact parallel to the external portions of the dykes which traverse the oolitic strata in the Hebrides.

4. The lavas of the Vivarrais have suffered more from the action of rivers than the recent currents in Auvergne: but the greater velocity and volume of the waters flowing in the narrow and steep valleys of the former country, may account for this, without supposing the lavas to be much more ancient. In Auvergne there are currents of ages unquestionably intermediate between the oldest and most modern; the remains of which are in many cases seen to follow the direction of the valleys, reposing upon ancient alluvions, and elevated above the modern lavas and the present rivers. The authors, however, do not admit that relative altitude can be considered as an invariable criterion of the relative antiquity of basaltic plateaus, as some writers have supposed.

5. In conclusion, a detailed account is given of the deposits at Mont-Perrier or Boulade, where the fossil remains of various extinct quadrupeds are found alternating with beds of transported materials of different kinds, which rest against the sloping side of a hill to the height of between 200 and 300 feet. This hill itself is essentially composed of tertiary marls, capped with basalt; but the basalt does not here overlie the alluvions, as has been asserted.

Phænomena perfectly analogous to those of Perrier are exhibited on the Allier at St. Maurice, and in the hill of Monton, not far distant: and these three sections, as well as that above mentioned at the new passage of the Sioule, all concur in proving that many valleys in Auvergne, anciently excavated through gneiss and lacustrine marls capped with old basalt, have at some remote periods been

filled up with transported matter, and afterwards been excavated a second time,—generally to a depth below their original bottom.

6. The authors conceive, with the writers already mentioned, that a satisfactory explanation of these phænomena may be derived from the effects of the latest volcanic eruptions of Central France. For the more recent lavas appear to have dammed up the channels of several rivers, and converted ancient valleys into lakes; wherein, as at Aidat and Chambon, alluvial matter is continually accumulating at present. The modern lava of Montpezat, in the Vivarrais, has thus obstructed the course of the Fontaulier, and given origin to a lake, since filled with river alluvion and volcanic ashes; and these deposits themselves, together with a part of the volcanic barrier, have been subsequently cut through by the action of the river and the waters of the lake. The early and more copious lava-currents of Auvergne must have occasioned larger lakes than those of recent periods; and these, as has been stated by other authors, seem to have been gradually filled up with materials introduced by rivers, and occasionally by floods, from the sides or craters of volcanoes, probably during their moments of eruption; through which accumulations new valleys were excavated by the continued action of the rivers:—as at Mont-Perrier, to about 100 feet; and at Maurice on the Allier, to the depth of 400 feet below their original bottoms. The high antiquity of these alluvial depositions is inferred from the fact, that their lowest remnants occupy as elevated a position on the sides of the valleys, as the lava-currents of intermediate age in Auvergne, and from the compactness and enormous mass of the trachytic breccias, which overlie and alternate with the alluvions.

7. Lastly, since the sand and gravel containing the fossil bones found on two different sides of the mountain of Perrier are overlaid by a vast mass of trachytic breccia, it is concluded, that the elephant, rhinoceros, hippopotamus, hyæna, tiger, wild cat and other quadrupeds, whose remains have been recently disinterred, must have been inhabitants of this district before the most recent cones and lavas of Auvergne had appeared, or the valleys had been excavated to their present depth; and even before the fires of Mont Dor were extinguished.

Jan. 2, 1829.—A letter was read, addressed to R. I. Murchison, Esq. For. Sec. G.S. &c. by G. W. Featherstonhaugh, Esq. F.G.S. "On the Series of Rocks in the United States."

Mr. Eaton has published in Silliman's Journal of Science, vol. xiv. a Synopsis of the rocks of North America. In the commencement of the present paper, the author, after having made himself acquainted by personal observation with the rocks of England,—states his opinion that the rocks in North America, which would appear from Mr. Eaton's Synopsis to succeed one another in an order perfectly irreconcileable with that which has been observed in the British Islands, do in reality follow the same order.

A comparative view of the respective systems of Mr. Eaton and the author of this letter will be conveyed in the following table:—

Series of North American Rocks.

(According to Mr. Eaton.)	(Mr. Featherstonehaugh.)
Superficial Analluvion.	

Stratified Analluvion.	
Post Diluvion.	
Ante Diluvion	Diluvium ? ?
Basalt	Basalt.
3rd Grauwacke. { Pyritiferous Grit; Pyritiferous Slate }	Coal measures of England.
Cornitiferous Lime Rock; Geodiferous Lime Rock	Carboniferous Limestone.
Lias { Calcareous Grit; Calcareous Slate }; Ferriferous Rock	Lower Limestone Shale.
Saliferous Rock; Millstone Grit	Old red-stone, similar to that of Monmouth.
2nd Grauwacke	Grauwacke Slate.
Metalliferous Lime Rock; Calciferous Sand Rock; Sparry Lime Rock	Transition Limestone; with Encrinites, Madrepores, Corals, Trilobites, Productæ, Spirifera, &c.
1st Grauwacke	Whetstone-Slate, and Alum-Slate.
Argillite	Clay-Slate, and Flinty Slate.
Granular Lime Rock	Primitive Limestone.
Granular Quartz.	
Talcose Slate	Talcose Slate.
Hornblende Rock.	
Mica Slate	Mica Slate.
Granite	Granite.

It is stated, moreover, to be the opinion of Mr. Eaton, that the coal measures of North America are analogous to those found at Cloughton on the Coast of Yorkshire; and consequently that the English oolite in which that coal is included, is represented by what he calls the 3rd Grauwacke. The author dissents altogether from this doctrine. His opinion is, that neither the oolite, nor indeed any of the beds which are in England higher in the series than the coal measures, are to be found in North America, at least, north of the 40° north latitude; unless, perhaps, a *very* thick and extensive bed of marl, destitute of fossils, but containing Septaria, and not unfrequently pebbles, (designated by Mr. Eaton by the term antediluvion), —which, though the author has not been able as yet to refer them to any of the regular formations, may hereafter be found to belong to some stratum in the English Series.

In confirmation of the opinions here advanced, the author gives a detailed account of observations made by himself in the course of an excursion from the City of Albany to the Hilderberg mountains, over a plain which extends about 30 miles from north to south, and 16 miles from east to west. The surface of this plain, which is 324 feet above the level of the Hudson River, consists of sand incumbent upon a very thick deposit of the marl above noticed, which is found also in various parts of the United States as far south as Louisiana. Near the Hudson River this marl is incumbent upon transition rocks, but at the Hilderberg mountains, on carboniferous limestone, containing the fossils usually found in that formation, and

imperfect seams of black chert or flint. This range is remarkable for its fissures and caves, one of which, more than 1500 feet long, situated in the town of Bethlehem, is minutely described by the author. Within this cavern is a pool of water, along which one of the attendants paddled himself in a small skiff, to the distance of 800 feet, in a course parallel to that pursued by the author, and separated by a screen of natural pilasters with occasional openings; this pool forms the head of a rivulet about one third of a mile from the entrance of the cave.—The author was unsuccessful in his endeavours to discover bones within the cavern, though it abounds in diluvial matter, which in some places presents a section of at least 7 feet in height.—There is another cave in the same neighbourhood, said to be still more extensive, which he proposes to explore.—No regular search for bones has yet been made in the caves of the United States. The only fossil bones hitherto found in any cave in that country, are those of the megalonyx, although the bones of the megatherium, elephant, mastodon, ox and horse, have been discovered in other situations:—but so little attention has been paid to the circumstances under which they occurred, that it is impossible to decide whether they were lodged in alluvial or diluvial deposits. In the author's opinion no fossil remains of the hyæna, rhinoceros, hippopotamus, bear, or tiger, have ever yet been found in the United States.

A letter was read, addressed to Dr. Fitton, President of the Geological Society, by Samuel Woodward, Esq., respecting some remarkable fossil remains found near Cromer, in Norfolk.

The author notices the limited extent of the marine formation of Eastern Norfolk, and is of opinion that its rejectamenta may point out the boundary of a former sea in that district.

The marine remains denominated Crag are found at Cromer, and westward of that town, at Coltishall, and around Norwich. To the eastward of these situations, instead of marine shells, a layer of ligneous and mammalian remains is found reposing on the chalk.—The author considers that a line drawn from Cromer, or a little east of it, and passing in a south-east direction towards Lake Lothing by Lowestoff, will very nearly describe the course of the antediluvian shore;—to the eastward of which, immense numbers of the fossil remains of the elephant, horse, deer, &c. mingled with the trunks, branches and leaves of trees, have been found, even to the distance of 20 miles out at sea; and on the Knole-sand the tusk of a Mammoth (drawings of which are annexed to the letter) was found in the year 1826, resembling those recently brought to England from Behring's Straits.

XXII. *Intelligence and Miscellaneous Articles.*

COMMEMORATION OF RAY.

THE proposal for employing the occasion of the second centenary of the Birthday of the illustrious John Ray*, which happened on

* See Phil. Mag. and Annals, N.S. vol. iv. p. 379.

the

the 29th of November last, for the purpose of a public expression of the high estimation in which he is held at this day by the lovers of every branch of Natural History,—was eagerly adopted: and the Public Dinner at Freemasons' Hall was attended by about 130 of the most distinguished cultivators and patrons of Science; including most of the officers of the Royal, Linnæan, Geological, Horticultural, and Zoological Societies, the Rev. the Provost of Eton, and several of the Professors of the Universities of Oxford, Cambridge, and London.

Davies Gilbert, Esq. M.P., the much respected President of the Royal Society, took the Chair, supported by His Grace the Duke of Somerset, President of the Royal Institution, Lord Astley, and other persons of distinction.

In proposing "The Memory of Ray," the Chairman said that he felt it to be his duty to express his sincere acknowledgements to the company for the high honour they had done him in calling him to the station he then so unworthily filled. He was aware that so gratifying a compliment had been paid to him, solely on account of his occupying the chair in which the too great kindness of the Fellows of the Royal Society had placed him; but he valued it the more from that reflection. That Society had been greatly honoured by having such a distinction conferred upon it; and he spoke the sentiments of every member of the Royal Society, when he returned to the company his sincere thanks on their behalf for this distinction. To take an active part on such an occasion must be gratifying to every friend of science and of virtue: but however much pleasure might be felt in participating in the proceedings of that day, and doing honour to the memory of a truly great man, still far more satisfaction must be derived from a consideration of the good effects which such a meeting must produce. Men who had done good service to their country, whether in the field of science or elsewhere, were entitled to its grateful remembrance; the display of that remembrance was calculated to incite others to an honourable struggle for similar distinction; and he was sure that when these proceedings should become known, they would tend greatly to promote the cultivation of the science of Natural History. On the merits of the illustrious man whose birth they had met to commemorate, although any remark from him must be unnecessary, he could not avoid saying a few words. The state of science at the period in which Ray lived must be so well known to those present, that it must be useless for him to refer to it, except to remind them of the difficulties with which he had to contend. To show the extent and importance of the labours of Ray, he would mention some of the principal works which he had produced. Among them were—Historia Plantarum Generalis; Catalogus Plantarum circa Cantabrigiam, &c., with Appendices; Methodus Plantarum circa Cantabrigiam, &c.; Catalogus Plantarum Angliæ et Insularum adjacentium; Catalogus Stirpium in exteris regionibus observatorum; Synopsis Methodica Animalium Quadrupedum, &c.; Synopsis Methodica Avium et Piscium; Methodus Insectorum; Observations made in a Journey through Part of the Low Countries, Germany, Italy, and France, with a Catalogue of Plants, not natives of England—to which

is

is added, "An Account of the Travels of F. Willughby through Spain, and A Collection of Travels into the Eastern Countries;" A Collection of English Proverbs and unusual Provincial Words; Dictionarium Trilingue; An Itinerary through England; Translation of Bishop Wilkins's real Character; various Sermons and Theological Works. The work published by Mr. F. Willughby, under the title of Ornithologiæ libri tres, &c. was known to be principally by Ray. In the Philosophical Transactions were printed, among other papers, On the Manner in which Spiders project their Threads; On the Dissection of a Porpoise; On the Swimming Bladders of Fish; On the Effects of Poisonous Roots, and the Virtues of the Leaves of Hemlock; and Observations (1699) made on the Comet that appeared at Rome;" and the last of his works which he should mention was "The Wisdom of God manifested in the Creation." This had been very frequently reprinted, and was clearly the prototype of a late celebrated book on the same subject. He had read the work of Ray with infinite delight, and it was alike an honour to his head and to his heart. But although his productions were so numerous, it was by their excellence that they commanded attention.—Ray was the first who reduced Natural History to a system, and prepared the way for those more perfect arrangements which have since had so salutary an influence on its cultivation. It was to his penetrating genius and indefatigable exertions that the civilized world was indebted for many most important discoveries. If he did not himself always arrive at the goal, he pointed out the road; and it was to his pursuing the course he had commenced, that we owed our present advanced state in many particulars of Natural History. Haller felt how much he owed to Ray, and he termed him "the greatest botanist in the memory of man." Ray very early distinguished himself. While at college he acquired a high fame, and some of the exercises he performed there have been found to be worthy of preservation even to this period: they formed the foundation of some of his late and important works.

"Of this inestimable writer," says Stillingfleet in his 'Calendar of Flora,' "whose works do honour to our nation, as a late disciple of the great Swedish Naturalist justly observes, I cannot help saying further, that no writer till his time ever advanced all the branches of Natural History so much as that sagacious, diligent, English observer, whose systematical spirit threw a light on every thing he undertook, and contributed not a little to those great and wonderful improvements which have since been introduced."

He was invited to become a member of the Royal Society in 1667; and he happily lived in amity with some of the most able and most virtuous men of his age. It was to do justice to the memory of such a man that they were then assembled, and he would not longer detain them from drinking with gratitude and veneration to the memory of the disciple of Bacon and friend of Locke, the intimate friend and contemporary of Willughby, and the precursor of Haller and Linnæus.

After toasts to "The Memory of Linnæus," and "The Improvement of Natural History,"—

Mr.

Mr. Bicheno (Secretary to the Linnæan Society) proposed, "Prosperity to the Royal Society." In giving such a toast, and in such a company, all remark must be unnecessary: still he might be allowed to say, that he proposed it from his heart, and that he did so principally from having, in an official situation in another society, experienced the good effects which proceeded from its fostering care, its kindly protection, and the powerful assistance it extended to other Societies, especially to that to which he belonged, when they had arrived at maturity. He then pronounced a warm eulogy on Ray, whom Cuvier had justly called *un Methodiste,* and whose works he had studied, still with fresh advantage, for the last twenty years. Ray was indeed a methodist. He was the first who arranged the grand outlines of Natural History, and enabled every one to become acquainted with the groups, the grand formations of nature. With the minute particulars of his subject, Ray had not much interfered; but he had originated that system of arrangement which gave perspicuity to the labours of others, and had accurately described the character of Nature's grand operations. No doubt he had gathered much from Grynæus; but still, even in the application of what he had gathered, he had done a vast deal. Most ages were proud of the advances they had made in science. While, however, we boasted of systematic arrangement, it should be remembered that, although the Natural Method was too much overlooked during the latter part of the last century, Ray first discovered its value. As a Zoologist, he was not prepared to speak of that great man; but in that branch of Natural History with which he might pretend to some acquaintance, he felt an admiration for his genius beyond the power of language to express.

The Chairman, on proposing "Prosperity to the Linnæan Society," gave a sketch of its origin. It was in truth a branch of the Royal Society. It had been formed on the suggestion of the late Sir Joseph Banks, in consequence of the multiplicity of business the Royal Society had been called upon to attend to. How well it had discharged its duties the scientific world well knew.

Mr. Lambert, Vice President of the Linnæan Society, returned thanks: and

Mr. E. Forster, Vice President and Treasurer, said, that born and educated in the same county with Ray, he had been taught from his infancy to admire that great man; and his admiration soon became veneration, from a study of his writings. Nearly forty years ago he had first visited his tomb, before it had long since undergone a repair at the expense of a gentleman present (Sir Thomas Gery Cullum). In his pilgrimages to Ray's tomb*, he had felt great delight in seeing also

* It has lately been repaired again by Mr. Walker, the rector of Black Notley. Mr. Tyson, in a letter to Mr. Cole, 1779, says, "One part of my ramble was to visit the last residence of that pious philosopher, Mr. Ray, Black Notley, *con amore.* I made a drawing of the church, and of his monument in the churchyard. The parish clerk had such remembrance of him from others, that he related various incidents. The clerk pointed out to me the farm-house which was once his dwelling. I there saw

also the place of his birth, the church in which he had been baptized; and in entering the house in which this good man had lived and died, it was pleasing to reflect that he was treading the very boards which Ray had trodden, and that he was looking perhaps on trees and plants which Ray had admired. The Linnæan Society was proud of being thought so nearly connected with the chief labours of Ray: but that great philosopher ought not to be considered merely as a botanist; we must look on his character as a man. "His religion was pure, and free from cant; his piety sincere, and without affectation; his morality consistent, and his manners gentle, affable and kind to those around him." One proof only of his integrity need be mentioned, his having resigned his fellowship; and, though reduced to poverty, refused all further preferment in the Church, because he would not declare that those who had sworn the solemn league and covenant might break their oaths; not that he had himself signed it, for he thought it an unlawful oath;—yet he could not conscientiously make the declaration required.

"Prosperity to the Geological Society," having been given;—the President (Dr. Fitton) in returning thanks, stated his concurrence in all that had been said respecting the great merit of Ray as a naturalist, and the excellence of his private character. Ray was in fact, he said, an honest man;—he gave up station and emolument rather than swear to what he did not believe;—and if such examples of integrity were not found amongst those who devote themselves to the pursuit of truth, where else, he would ask, should they be looked for?—In Geology, Ray made many sagacious observations, and entertained some opinions much beyond the state of the subject in his own time.—But our chairman had justly stated, that Geology, as a distinct branch of knowledge, had not then obtained a name; and in fact it supposes such an advanced state of scientific inquiry, that it scarcely could have existed, till a much later period. The geologist, it is true, is in a great measure nothing more than a physical geographer,—and all that constitutes his exclusive business lies within a very narrow compass;—but he requires a high degree of cultivation in several other departments of inquiry with which his own is allied,—especially in chemistry, zoology, and botany;—for what without these would be Geology at the present day?—Instead of regretting this state of dependence, he was rather disposed to rejoice at it, since it tended to produce more frequent intercourse with those who are engaged in the pursuit of other branches of natural science; so that when he looked about him in such an assembly as the present one, he felt that he was surrounded with benefactors; and great as the merit of Ray unquestionably was, as an original observer of the earth's structure, he was disposed to rate still more highly the services he had rendered to Geology, by contributing to the perfection of those other de-

saw his library (that is, the room which once contained his books), and his garden below it,—about an acre of ground. Here the father of English Naturalists lived employed and happy."

partments

partments of Natural History, to which his attention was principally devoted. But there were more general views,—which made him rejoice that a meeting like this had been brought together.—It proved, and must if possible contribute to increase, the cordiality of intercourse and feeling, that distinguish, so very creditably, the naturalists of this country;—and it tended also to increase their power and resources. It had been said, perhaps with too much truth, that England, notwithstanding the number and wide distribution of its colonies,—has done much less to advance the Natural History of foreign countries than might have been expected: occasional meetings like the present must facilitate the inquiries of our naturalists, not only by enabling them to combine their own exertions, but by impressing upon the Government of the country, the importance and value of the researches in which they are engaged. In a country like ours, the Government itself could not, perhaps, be expected to originate measures for the improvement of natural knowledge;—it is for you, therefore, to suggest them;—the Government can have no other wish, than to give effect to the suggestions of disinterested and well-informed men.—On every ground therefore,—both of general feeling, and as a member of a Society, to the success of which the progress of the other departments of Natural History is almost essential,—he was happy that this meeting had been held, and had peculiar pleasure in being present upon such an occasion.

Mr. Greenough passed a high eulogy on the character of Ray; and said that the meeting gave a strong proof that honourable exertions were never thrown away. Independent of the inward pleasure they gave, they were sure of receiving the admiration of the good and the informed. After some remarks upon the rapid spread of the study of Geology, he concluded by expressing his hope that that science would daily become more general.

"The Zoological Society" was then given; and Mr. Vigors, in returning thanks, spoke of the high sense now entertained of Ray's merits as a philosophical Zoologist; and alluded to the advantages which were to be expected from the establishment of the Zoological Society.

On the healths of the Naturalists of Great Britain and Ireland being drunk, coupled with the name of Mr. Kirby, the Rev. Gentleman said that he had never before addressed a public assembly of a festive character; but he felt it right to take that opportunity of testifying his admiration of the great and good Ray. He was great as a natural philosopher, and great also as a moral philosopher. He penetrated the world of science further than any of his contemporaries, and by his exertions formed a bright constellation of information, whose beams had served as a guide and beacon to more modern labourers. In Entomology, the branch of science to which he himself was devoted, the naturalist of the present time was indeed deeply indebted to Ray, who had combined the system of Aristotle with that of Swammerdam, and cleared the way for Linnæus. Much had been done to unveil nature, but still much remained to be done; and he hoped

that a course of perseverance would be pursued until all was accomplished.

The healths of Cuvier and Jussieu, and the Naturalists of Europe, were drunk with much approbation.

Dr. Buckland's health, and Prosperity to the University of Oxford, having been most cordially received; the learned Professor addressed the meeting as follows:—

"The President of the Royal Society has already informed you, by a detailed examination of his extensive Works, how great are the advantages which Natural History has derived from the labours and the genius of Ray; and in the presence of so many illustrious botanists as I now see assembled in this place, it would be highly presumptuous in me to say one word on the benefits, the inestimable benefits, which he has conferred on the science of Botany. My excellent friend and colleague Professor Sedgwick, were he now present (and I regret that severe illness alone has caused his absence), would tell you how extensively the influence of his exertions and his example have operated to excite a taste for natural knowledge in the University of Cambridge,—a taste which he, a member of the same College, and animated with the same spirit, as the immortal Ray, maintains and keeps alive in the present generation with a zeal and talent worthy to follow his great predecessor in the field of Natural Science.

"As a member of the University of Oxford, I rejoice to bear most ample testimony to the lasting benefits which the exertions of the age and friends of Ray have transmitted to that seat of learning, to which it is my happiness to belong. The labours of Lister, Plot, and Ashmole, of Lloyd, and of Robert Boyle, and the establishment of the Botanic Garden and of the Ashmolean Museum, mark in our University the burst of a kindred flame to that which Ray had excited in the sister University; and laid in Oxford the foundation of that right method of investigation, and of making collections in Natural History, which have been transmitted to our own time. In the department of science to which my own attention is peculiarly directed, the genius of Ray had made advances that would do honour to the present day. In his Treatise on the Wisdom of God in the Creation, he points out examples of design and utility in the form and structure and composition of our planet, founded on extensive and accurate observation of facts, and illustrated with sound argument, mixed with much good feeling and good sense. And in his Discourses on Chaos, Creation, and Deluge, there is a knowledge of many phænomena of the earth's surface, the discovery of which the present generation are too apt to consider as exclusively their own:—that important and leading doctrine of the Huttonian theory, which attributes the elevation of islands, mountains, and continents to the force of vapour acting from below, is set forth in words that form almost an exact parallel to the statements of the same theory in Playfair's Illustrations; the theory in neither case was new; it was indeed handed down from high antiquity; but it is illustrated by Ray, with such abundant arguments and examples derived from the effects of earthquakes and volcanoes which in his time raged so terribly in Jamaica,

Jamaica, and with such copious and judicious references to the authentic records of the elevation of Thera, Therasia, and other volcanic islands, that the essence and leading features of much that has been written since, on the theory of elevation and disturbance by subterranean vapours, have been anticipated by Ray. His remarks on the Structure of Mountains as containing and affording access to metallic veins; their influence on climate, and use in collecting clouds for the formation of rain, and production of rivers; his observations also on the general diffusion of Springs, and their never-failing supply of water, as derived from rains and dews,—show much accurate observation, and point out correct conclusions which have been often repeated, but rarely surpassed by his followers on these subjects.

"In another curious and extensive branch of geological inquiry which relates to the history of fossil shells, he contended (in opposition to the prevailing theories of his predecessors and of many of his contemporaries), that they were not accidental results of the plastic power and the sport of Nature, but the real and true exuviæ of animals that formerly inhabited them. He contended further, that these shells for the most part belong to species unknown in our existing waters, but recommends caution in pronouncing them to be absolutely extinct until we know the contents of the bottoms of all our deepest seas. Can it be said that modern geology has advanced on this point much further than Ray?

"Again, with respect to the prevailing taste and studies of his time, he complains that men are too much occupied in the study of words, and too regardless of the study of things; exclusively absorbed in attending to the works of the creature, and regardless of the works of the Creator; admiring and collecting carved ivory and curious instruments of human invention, but insensible of the exquisite and ten-thousand times more admirable mechanism that pervades the animal and vegetable worlds.

"He complains further, that men are too much disposed to rely on the authority of others, and too little willing to undertake the labour of investigating Nature for themselves; he stimulates them to exertion by the hope of useful discoveries, any one of which may amply reward the labours of a life.

"Such were the feelings and such the principles by which his energetic soul was ever actuated; such the exertions to which he called on his contemporaries;—constant and strenuous exertions to extend the sphere of human knowledge and useful discovery, and thereby advance the welfare of mankind. And surrounded as I now am by a host of individuals, the most illustrious members of the numerous learned and philosophical Societies which in our day have arisen to adorn and benefit our country, I feel that you all not only sympathize with me in admiration of the great example he has set us, but yourselves rejoice to follow in those paths of useful labour which Ray not only pointed out, but was himself indefatigable to pursue.—To do just honour to the memory of so great and good a man is the object of this day:—A man whom as an indivi-

dual we must ever esteem, love, and venerate, and whose name the annals of Philosophy will never cease to record among the first founders and benefactors of Natural Science."

On giving "The University of Cambridge," the Chairman took notice of the expulsion of Ray from that University, which harsh act he was disposed to attribute to the persecuting spirit which raged without the walls of that learned seminary. He could say of many of the present members of Trinity College, that they regret that the violence of the times had compelled their predecessors to acquiesce in the retirement of Mr. Ray from his Fellowship, for refusing to subscribe a declaration altogether unwarrantable. Oxford had as much to answer for in regard to her treatment of Mr. Locke.

The Rev. Professor Henslow returned thanks. He remarked that the University of Cambridge had, so far as the marble or the canvass could make amends, endeavoured to atone for the little, or, he should rather say, the great, injustice which Mr. Ray had sustained. The bust of that great man was ranged by the side of those of Newton, Boyle, Barrow, Dryden, and Willughby; and his portrait was considered to confer honour on the place in which it was. But Cambridge might with justice boast of possessing a far more powerful proof than those, of the estimation in which it held the genius and conduct of Ray. His spirit still lived there. And although the study of Natural History had not yet been brought to that degree of perfection there which it might be, he hoped the day was not far off when it would command general attention: such pursuits he considered the best correctives of fanaticism and bigotry.

"The Universities of Edinburgh, Glasgow, and London," and the healths of Baron Humboldt and Dr. Wollaston, having been severally drunk, the Chairman retired, amidst the applauses of the company.

The health of Mr. Children, who suggested the commemoration, was then given with hearty approbation, and the company separated, after having spent a day which they will long remember with delight *.

RED FERROCYANATE OF POTASH.

M. Girardin obtains this compound by passing chlorine gas into a moderately strong solution of the common ferrocyanate of potash; and this is to be continued until the solution ceases to produce any effect when added to a solution of peroxide of iron. The liquor is then to be concentrated to two thirds of its volume, and set aside in a moderately warm stove to crystallize: after some time yellow, brilliant, and slender crystals are obtained in the form of roses; by a second crystallization very long needleform crystals are procured in tufts. These crystals are ruby-coloured, transparent, and very brilliant; their form appears to be an elongated octahedron.

The principal character of this salt is that of indicating the protosalts of iron, precipitating them blue or green, according to the proportion in solution, and on the contrary not precipitating the persalts of iron. This reagent, according to M. Girardin, is much more sensible than the common ferrocyanate of potash; for it is capable of

* Might not our chemists and natural philosophers with great propriety follow this example, by celebrating the centenary of Priestley in 1833?

detecting

detecting 1-90,000dth of protoxide of iron, while the latter does not detect less than 1-1800dth of the protoxide. The red ferrocyanate of potash is soluble in twice its weight of cold water, and less than its own weight of boiling water. It is insoluble in alcohol, does not act upon litmus, but renders syrup of violets green. The concentrated solution in large quantity is almost black, its colour being so extremely deep, but in small portions it is transparent and of a greenish red colour. A very small quantity renders a considerable portion of water green. In the formation of this salt half of the acid of the ferrocyanate is destroyed by the chlorine, and the alkali of this is combined with muriatic acid. The ferrocyanates of soda, ammonia, barytes and lime, are all converted into red ferrocyanates by chlorine.

The red ferrocyanate of potash precipitates tin white; silver and zinc of an orange colour; nickel, bismuth and titanium brown; copper of a dirty brown; cobalt and uranium different shades of reddish brown; both oxides of mercury brown. Lead is not precipitated; but after some time reddish-brown crystals are deposited, which when decomposed by sulphuric acid, separate perferrocyanic acid, which crystallizes in needles, reddens litmus paper, and has at first an acid and afterwards a styptic taste. When slightly heated it separates into hydrocyanic acid and Prussian blue.—*Hensman's Repertoire de Chimie*, Aug. 1828.

ON GALLIC ACID, TANNIN, AND A PECULIAR PRINCIPLE IN COFFEE.

M. Pfaff states the following as the results of the experiments which he has made on the above-named substances:

That tannin ought to be considered as an immediate principle of the vegetable kingdom, and not as composed of gallic acid or any other acid, and a peculiar vegetable body.

That the character which especially distinguishes tannin from gallic acid, is its action with solution of isinglass, a weak solution of gold, a solution of titanium, tartar emetic, the alkaline carbonates, and the salts of the vegetable alkalies. Gallic acid reduces gold perfectly, tannin merely reduces it to the state of a hydrate of the purple suboxide; tincture of galls acts like tannin. Solution of titanium precipitates tannin and tincture of galls of an orange colour similar to the golden sulphur of antimony; whilst by gallic acid the same solution is merely rendered opalescent, and of a yellow colour. In the solution of tartar emetic, gallic acid occasions immediately a white precipitate; the solution of tannin renders it only slightly turbid, and does not colour it for a considerable time.

The alkaline carbonates render gallic acid brown, which by the gradual action of the air changes to green; they precipitate tannin abundantly, and the supernatant liquid is brown, but it becomes very slowly of a dirty green. The acetates of morphia and strychnia, and the sulphates of quina and cinchonia, do not precipitate gallic acid, but they precipitate tannin very readily.

Gallic acid has a very marked action upon ammonia and the fixed alkaline carbonates. The smallest particle of carbonate of soda existing

isting in a mineral water or in a fluid of animal origin is discovered by a green colour gradually developed by the action of the air.

The property which coffee possesses of rendering albumen green by the action of the air, is derived from the gallic acid which it contains; from which it follows that the reputed green colour of coffee is a product, and not an educt or immediate principle of the bean. Gallic acid renders albumen green; the effect is gradually produced; it is strongest on the surface of this substance. As albumen contains carbonate of soda, it may be supposed that the green colour is derived from the action of this alkali; and this appears to be the case, for on saturating the alkali of the albumen with vinegar, no green colour is produced.—Plants which contain emeta or veratria are devoid of gallic acid. When tannin is combined with the alkalies, it appears to approach the nature of gallic acid.—*Ibid.*

NEW EXPERIMENTS ON THE COMBUSTION OF COAL-GAS.

The Rev. W. Taylor, of York, in performing some experiments on the combustion of coal-gas, has obtained results which promise to be of public importance. He has discovered very simple means by which the illuminating effect of a common argand gas-burner may be much increased, while its flame is proportionately enlarged. The following brief statement will show the nature of the experiments, which have been repeated by several members of the Yorkshire Philosophical Society, as well as by many inhabitants of York.

Exp. 1.—A piece of wire-gauze being laid upon the glass chimney of a common argand *gas*-burner, the flame is immediately enlarged to twice its former dimensions, and its light fully doubled.

(A similar experiment being tried with a common argand *oil*-lamp, or reading-lamp with a flat wick, the flame is often enlarged, but so discoloured as to yield less light.)

Exp. 2.—Place the finger, or a bit of cork, so as to close the lower opening of the interior air-passage of a common argand *gas*-burner:—the flame experiences a sudden enlargement, with an increase of light nearly equal to that in Exp. 1.

(The inner air-passage of an argand *oil*-lamp being closed, the flame is greatly deteriorated and darkened.)

Exp. 3.—The air-tube of an argand *gas*-burner being stopped as in Exp. 2, and the flame consequently enlarged, no further change happens when wire-gauze is laid on the top of the glass chimney.

Exp. 4.—Over the glass chimney of a *single-jet* gas-burner, wire gauze being laid, produced no enlargement of the flame, and no increase of the light.

In an experiment at the rooms of the Mechanic's Institute, York, it was found that *one hundred* feet of gas were consumed in three hours and twenty-five minutes, by six Argand gas-burners in the ordinary state; while the same gas-burners, *provided with wire gauze caps* to their chimneys, yielded an equal light for an equal time, but consumed only about *fifty* feet of gas.

York, Dec. 9, 1828. J. PHILLIPS.

SAN-

SANGUINARIA,—A NEW VEGETABLE ALKALI.

M. Dana gives the following process for separating the above-named alkali from the *Sanguinaria canadensis*, Linn. called in America blood-root, on account of the red juice which it yields. Digest for some time the powdered root in pure alcohol, then pour the tincture, which is of a very fine red colour, into water, which precipitates a brownish matter that reddens turmeric paper. To obtain this matter in a pure state, it is, however, better to add ammonia to the tincture, and afterwards wash the precipitate in boiling water, with powdered charcoal, and throw the whole upon a filter. The mixture remaining upon the filter is afterwards treated with alcohol, which dissolves the new substance, and by evaporating the spirit, it is obtained in the state of a pearly white matter; its taste is acrid, it reddens tincture of turmeric, and presents all the characters of the vegetable alkalies; that is to say, it combines with acids to form different salts, which are of various tints of red. When exposed to the air, sanguinaria becomes of a very distinct yellow colour; it is insoluble in water, very soluble in alcohol and æther. It appears to exist in the plant combined with an acid, the nature of which is under examination.—*Hensman's Repertoire de Chimie*, Aug. 1828.

ANALYSIS OF RHUBARB AND OF THE YEW.

Professor Peretti has lately subjected Rhubarb to examination, and according to his analysis it contains

Tannin.	Volatile oil.
Gallic acid.	Resin.
Malate of lime.	A solid yellow colouring matter.
Gum.	Oxalate of lime.
Sugar.	Fibrous matter.
Fixed oil.	

The ashes gave carbonate of potash, sulphate of potash, chloride of potassium, oxide of iron, carbonate and sulphate of lime, and silica.

The resin is the active part of the rhubarb; according to Dr. Tagliabo in doses of 10 or 12 grains it operates strongly, and without griping. A remarkable circumstance in the analysis of M. Peretti, is the discovery of sugar, which had not been previously announced. Its presence was discovered by a process which he supposes to be applicable to a great number of cases. He boils the alcoholic tincture of rhubarb until it becomes colourless; he filters and evaporates. The sugar remains mixed with a little malic acid and gum.

The Yew yielded M. Peretti the following substances:

Chlorophile.	Mucilage.
Tannin.	Bitter volatile oil.
Gallic acid.	Bitter uncrystallizeable matter.
Malate of lime.	Yellow colouring matter.
Resin.	Sugar.

According to M. Peretti, similar characters occur in the colouring matters which are met with in rhubarb, yew, turmeric, madder, &c. and probably in all plants which furnish yellow colouring matter.

They

They act similarly with warm and cold water, alcohol, æther, potash, ammonia, nitric acid, and chlorine; heated in a retort the same effects are produced, and also by sulphate of alumina, and electricity; the latter agent has been especially observed as to the effects which it produces upon madder. The hot infusion gave crimson-coloured flocculi at the positive pole instead of yellow ones, and as they were formed the liquor became colourless. These flocculi were insoluble both in boiling water and in alcohol; they do not melt by heat, and at the negative pole they give out hydrogen.

Tincture of litmus subjected to the action of the battery in two tubes, communicating with each other, became red at the positive, and of a deeper blue at the negative pole. The red liquor was acid, and the blue one alkaline. By evaporation the red liquid left a substance of a deep red colour, susceptible of being reduced to powder. It was rendered blue by the alkalies, and was soluble in æther. By spontaneous evaporation small particles of a bright red colour were formed, adhering to the vessel; this substance was less soluble in alcohol.

The blue liquid again subjected to the action of the battery, became colourless at the negative pole, and gave red matter at the positive. The colourless liquor, evaporated and burnt, left potash or soda.

The red liquid give scrimson precipitates with the persulphate of iron and nitrate of silver, and a violet precipitate with the subacetate of lead. Tincture of litmus even forms crimson precipitates with barytes, water, muriate of barytes, subacetate of lead, sulphate of zinc, persulphate of iron, nitrate of silver, and sulphate of copper.—*Journal de Pharmacie,* October 1828.

NEW CLASSIFICATION OF THE COLOURS OF THE RAINBOW.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,—As every improvement, however small, in scientific classification, is of some importance, it is presumed that the following will be thought not unworthy of a place in your miscellany.

I have often seen the rainbow, when very bright, repeated three or four times, every repetition being gradually fainter; each set of colours being half the width of the preceding (like the repeated notes of the musical octave on a divided string or line); and succeeding according to the following classification, which I consider as more scientific than the common enumeration.

Red.

Orange, divided into { Reddish, called scarlet. / Yellowish, called orange.

Yellow.

Green, divided into { Yellowish, called Pomona. / Bluish.

Blue.

Purple, divided into { Bluish, called indigo. / Reddish, called violet.

Red.

Orange, &c.

Here

Here are three simple colours, red, yellow, and blue; and three compound colours, orange, green, and purple, each divided into two species; whereas in the received enumeration, we have a confused intermixture of genera and species in the same predicamental line.

Dr. W. H. Wollaston, in the Phil. Trans. for 1802, p. 378, infers from some experiments, that a beam of white light is separable by refraction, not into three, but *four* simple colours, viz. red, yellowish green, blue, and violet; but of these the very term "yellowish green" betrays its composition, and as to violet, its components have been already shown. R.

Grafton Street, Dublin.

CLAW OF THE IGUANODON.

Among the fossil bones discovered by Mr. Mantell of Lewes, during the present year, in the Hastings strata of Sussex, are two specimens, which M. Cuvier has determined to be the ungueal bones, or those which support the nails, of the Iguanodon. The largest is four inches in length; while the corresponding part in a recent Iguana three feet long, is but two-fifths of an inch.

ON LUMINOUS ARCHES OF THE AURORA BOREALIS, SEEN AT MANCHESTER ON THE 1ST AND 26TH OF DECEMBER 1828; AND ON THAT OF THE 29TH OF SEPTEMBER, AS SEEN AT DUBLIN. BY JOHN BLACKWALL, ESQ. F.L.S., &c.*

At six o'clock on the evening of Monday, the 1st of December 1828, a luminous arch of the aurora borealis was seen at Manchester, by Mr. T. Blackwall, Sen., Mr. T. Blackwall, Jun., and several gentlemen of my acquaintance, from whom I obtained the following particulars. The arch, which consisted of a belt of pale white light, between four and five degrees in breadth, was bisected by the plane of the magnetic meridian, which it crossed at right angles; its vertex had an elevation of about thirty degrees above the horizon, and its eastern limb passed through the body of the constellation Ursa Major. At ten minutes past six the arch rapidly decreased in brilliancy, and soon after entirely disappeared.

From a horizontal light situated in the magnetic north, which had accompanied the arch, and still continued very apparent, several beams or streamers shot upward shortly after the arch had vanished. I may add, that between the hours of nine and ten, on the same night, a horizontal light of the aurora was seen at Wirksworth, in Derbyshire, but the person who made the observation had not an opportunity of witnessing the arch, as he was occupied within-doors at the time it was visible.

I shall now proceed to offer a few observations, communicated to me by Mr. T. Blackwall, Jun., relative to another well defined arch

* Communicated by the Author.

of the aurora, seen at Manchester, on the 26th of December, at six o'clock in the evening. It was at right angles with the magnetic meridian, and appeared to rise gradually towards the zenith, moving at the rate of about five degrees in ten or twelve minutes. At ten minutes past six the upper edge of the arch seemed to touch the star Benetnasch, in the tail of Ursa Major, and in ten minutes more it ascended to the star Mizar, in the same constellation; Benetnasch being then a little beneath its lower edge. The arch at this period—twenty minutes past six—had an elevation of about twenty degrees above the horizon: it waxed and waned repeatedly, and soon after disappeared, its continuity having been previously interrupted by a break in its eastern limb. It was succeeded by a horizontal light in the magnetic north, but no streamers were perceived.

According to a paragraph from the Hull Packet, given in the London Courier of the 31st of December, this aurora was visible at Hull, from six in the evening till nearly seven, the arch being about twenty-five degrees above the horizon, where its altitude was greatest.

I am induced to forward the foregoing imperfect account, for insertion in the Philosophical Magazine and Annals, in the hope that it may influence persons who have noticed these rare and interesting phænomena in other parts of the kingdom, to make public the results of their observations.

The fine luminous arch of the aurora which occurred on the evening of the 29th of September 1828, accounts of which are published in the Philosophical Magazine,—see the Numbers for November and December last,—was visible at Dublin, where it was seen at half-past seven o'clock, by some of my friends; the vertex of the arch, according to their reports, being at that time about ten degrees south of the zenith.

Let it be remembered, that it is from particulars carefully ascertained, relative to the altitude of the summits of the luminous arches of the aurora above the horizon, that the true height of this meteor above the earth's surface is most likely to be determined.

PROPOSAL FOR A REPOSITORY FOR MANUSCRIPTS.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

Notwithstanding the numerous Literary Institutions already existing in London and several provincial towns, I shall venture to propose another, hoping that the suggestion may be approved of and carried into effect. There can be no doubt but many very valuable *manuscripts* are destroyed by being burnt amongst useless letters and other papers, or sold for waste paper. To prevent the destruction of such in future, and for collecting them together, it is suggested that a subscription be entered into for purchasing *manuscripts*, and keeping them in a library, which may be called the *London Manuscript Repository*. I am well aware that objections will probably be raised to this plan from very good motives. It may be argued, that if such an establishment take place, many private letters which ought to be destroyed

destroyed will be preserved: on the other side of the question it may be conjectured, that many letters which would probably have been sold as waste paper will be looked over before they are parted with for this proposed *Repository;* and those which are found to be improper to be sent to it, will be destroyed by the families to whom they belong, to prevent their being made public. Those persons who now willingly sell old letters and other writings for waste paper, probably rest satisfied that they will really become such, and then be destroyed: but those who collect *manuscripts* from waste-paper shops, must well know that private letters are bought and preserved; some containing family anecdotes, which, if made public, might give great uneasiness to the descendants of the writers of them. The effects of such a Repository appear to be *two-fold,* the *preservation* of many valuable papers from the flames, and the *destruction* of papers which would have been *preserved* by private collectors. Should this proposition be thought by you worth noticing, you will oblige the writer of it by giving it an early insertion in your Magazine. If such a *Repository* should be established, there can be little doubt but many presents will be made to the managers of it by private individuals.

CHIROGRAPHILOS.

18th December, 1828.

SUGGESTIONS TO BAROMETRICAL OBSERVERS.

If it would not be too much trouble to your correspondents who favour your readers with their registers of the barometer, I would beg of them information on one or two points, without which they cannot be compared with one another, or with other registers. I wish to know,

1st, The height of the basin of the barometer above the level of the sea at mean tide.

2nd, The temperature of the barometer: for which purpose there should be a thermometer attached, which should be registered each time the barometer is registered; or if this is found inconvenient, at least the mean temperature of the room in which the barometer hangs should be obtained as accurately as may be.

3rd, The particulars of the instrument: viz.

§ 1. Whether an open-cistern barometer or not.

§ 2. The proportion between the surfaces of mercury in the basin and in the tube.

§ 3. The diameter of the inside of the tube.

§ 4. Since only one point of the graduated scale can be correctly measured from the varying surface in the basin; Which is that point? and At what temperature is it correct?

This information would add much to the value of the copious registers reported in the Philosophical Magazine and Annals, and oblige

Canonbury, 17th Jan. 1829. S. S.

OBITUARY:—MR. THOMAS TREDGOLD.

We have just heard with the sincerest regret the death of our much-respected and valuable correspondent Mr. Thomas Tredgold, which happened on Wednesday, January 28th, at the age of forty, at his house in Lisson Grove. Science and its practical application have thus lost in the prime of life a most zealous and able promoter.

LIST OF NEW PATENTS.

To S. Jones, of the Strand, for a new and improved method of producing instantaneous light.—Dated the 10th of December, 1828. —2 months allowed to enroll specification.

To T. W. C. Moore, of New York, now residing at Hampstead, for an improved method and machinery for manufacturing hats or caps.—10th of December.—6 months.

To V. Llanos, of Hampstead, for an improvement on bitts.—15th of December.—6 months.

To J. Forbes, of Cheltenham, for his method of consuming smoke. —15th of December.—6 months.

To R. Williams, of Tabernacle Walk, Middlesex, engineer, for improvements in the application of elastic and dense fluids to the propelling of machinery.—15th of December.—6 months.

To Anton Bernhard, of Finsbury Circus, engineer, for improvements on wheels or apparatus for propelling vessels, &c.—15th of December.—6 months.

To J. D. Whitehead, of Oakview Mills, Saddleworth, Yorkshire, for improvements in making cartridges for sporting and other purposes.—15th of December.—6 months.

To J. Morfitt, of Cookridge, near Leeds, for improvement in retorts used by bleachers and makers of oxymuriatic acid or oxymuriate of lime.—15th of December.—2 months.

To J. Slater, of Birmingham, for improvements in axletrees and the boxes for carriage wheels.—15th of December.—6 months.

To J. Levers, of Nottingham, machinist, for improvements in machinery for making lace or bobbin-net.—18th of December.—6 mon.

To W. Stead, of Gildersome, Yorkshire, millwright, and J. Stead, of Doncaster, for a paddle-wheel on a new principle, for propelling steam-packets, &c.—18th of December.—2 months.

To Joseph Charlesworth and Joshua Charlesworth and S. A. Mellor, of Holmfirth, Yorkshire, for improvements on gig mills for the raising and finishing of woollen cloths, &c.—18th of December.—2 months.

To J. Simister, of Birmingham, for improvements in manufacturing a cloth or fabric, and the application thereof to the making of stays and other articles of dress.—18th of December.—6 months.

To E. Josephs, of Haydon-square, Middlesex, for improvements on the wheels, axletrees, and other parts of carts, &c.—18th of December.—6 months.

To F. H. N. Drake, of Colyton House, Devon, esquire, for the invention of a peculiar till.—18th of December.—4 months.

To W. Parr, of Union Place, City Road, gentleman, and J. Bluett, of

of Blackwall, Middlesex, ship-joiner, mast and block-maker and pump-maker, for their method of producing a reciprocating action by means of rotatory motion, to be applied to the working of all kinds of pumps and other machinery.—22nd of December.—2 months

To G. Rodgers, cutler, J .C. Hobson, merchant, and J. Brownill, cutler, all of Sheffield, for their improvements on table forks.—23d of December.—2 months.

To O. H. Williams, of North Nibley, Gloucestershire, esquire, for his improvements in the paddles and machinery for propelling ships and other vessels on water.—7th of January, 1829.—6 months.

To S. Gritton, of Pentonville, Middlesex, surgeon, and late of the Royal Navy, for his improved method of constructing paddles to facilitate their motion through water.—7th of January.—2 months.

To F. Neale, of Gloucester, barrister-at-law, for his machinery for propelling vessels.—7th of January.—6 months.

To W. Taft, of Birmingham, harness-maker, for certain improvements in harness and saddlery.—7th of January.—6 months.

To A. Robertson, of Liverpool, ship-carver, for certain improvements in the construction of paddles for propelling ships, boats, or vessels on water.—7th of January.—6 months.

To J. Deakin, and T. Deakin, of Sheffield, merchants and manufacturers of hardware, for certain methods of making, from horns and hoofs of animals, various articles; namely, handles of knives, &c.—14th of January.—2 months.

To J. Dickinson, of Nash Mill, in the parish of Abbots Langley, Hertfordshire, paper manufacturer, for his improved method of manufacturing paper by machinery; and also a new method of cutting paper and other material into single sheets or pieces by means of machinery.—14th of January.—6 months.

To T. Smith, of Derby, engineer, for his improved piece of machinery, which being combined with parts of the steam-engine or other engines, such as pumps, fire-engines, water-wheels, air-pumps, condensers, and blowing-engines, will effect an improvement in each of them respectively.—14th of January.—6 months.

To C. Hewes, of Manchester, engineer, for certain improvements in the form and construction of windmills and their sails.—14th of January.—6 months.

To J. Udney, of Arbour Terrace, Commercial Road, Middlesex, esquire, for certain improvements on the steam-engine.—14th of January.—2 months.

To W. E. Cockrane, of Regent-street, Middlesex, for an improvement on paddle-wheels for propelling boats and other vessels.—14th of January.—6 months.

To J. M. Ross, of No. 6, Symonds' Inn, Middlesex, ironmonger, for an improved tap or cock for drawing off liquids.—19th of January.—2 months.

METEOROLOGICAL OBSERVATIONS FOR DECEMBER 1828.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·32 Dec. 2, 13, & 14. Wind E.—Min. 29·20 Dec. 8. Wind S.W.
Range of the index 1·12.
Mean barometrical pressure for the month ..... 29·930
Spaces described by the rising and falling of the mercury..... 7·260
Greatest variation in 24 hours 0·630.—Number of changes 20.
Therm. Max. 57° Dec. 4, 13, & 22. Wind W.S. & S.W.—Min. 34° Dec. 28. Wind N.
Range 23°.—Mean temp. of exter. air 48·40°. For 30 days with ☉ in ♐ 50·77
Max. var. in 24 hours 16°·00—Mean temp. of spring water at 8 A.M. 54°·34

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 29th ..... 100°
Greatest dryness of the air in the afternoon of the 2nd..... 57
Range of the index..... 43
Mean at 2 P.M. 74°·2—Mean at 8 A.M. 80°·0—Mean at 8 P.M. 79·9
—— of three observations each day at 8, 2, and 8 o'clock..... 78·0
Evaporation for the month 0·95 inches.
Rain near ground 3·825 inches.

Summary of the Weather.

A clear sky, 3; fine, with various modifications of clouds, 8½; an overcast sky without rain, 12; foggy, ½; rain, 7.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
13	5	30	1	13	19	20

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	½	2	4½	6½	8½	7	1	31

General Observations.—The state of the weather this month was mostly wet and overcast, with a series of boisterous gales, and a very humid air near the earth; yet it has been remarkably mild for the season, as only three or four slight frosts have occurred.

In the night of the 7th inst., much rain and hail fell here, accompanied with a heavy gale from the S.W., and vivid lightning for several hours, with some distant thunder: notwithstanding the gale died away about seven o'clock in the morning of the 8th, still the atmosphere, to an unlimited extent, presented an unusually turbid and frequently an electrical aspect, which threatened a renewal of the storm; and about eleven the gale sprung up again from the S.W., with vivid lightning and long reverberating peals of thunder. Soon after twelve, an electric ball fell into a field on the western side of the town, when the expansion of the air was so great, that, in regaining its position, all the houses were sensibly shaken. Several flashes of lightning from the tail of the storm were perceived in the sunshine immediately it had passed the meridian. No damage was done here; but the darkness of the sky and the vivid lightning at noon were very appalling, and served to point out the great density and electric state of the passing *nimbus:* a few of its effects are as follows. The spire of Ryde Church in the Isle of Wight was considerably damaged by the electric fluid; and the main-mast of the Roebuck cutter lying at the Motherbank was much shattered, as was also a poplar tree at Farlington, and torn up by the roots. The spire of St. Michael's Church at Southampton was slightly damaged, and the tower of Stoke Abbot Church near Beaminster, Dorset, was reported

ported to have been thrown down; and many thatched houses and barns unroofed,and trees rooted up in that neighbourhood. The steeple of Nunren Church, near Carlow, is reported to have been riven to its base. Much damage has also been done by this irresistible storm in other parts of Ireland, and many lives lost by the sudden inundation of the low lands from the overflowing of the rivers in that country; also in Scotland and in Wales, where it appears to have happened nearly a day sooner than it was felt in the southern parts of England. In the present enlightened age, it is really astonishing that recourse is not more generally had to the fixing of *pointed* metallic conductors, or connected iron rods, to lofty spires and high ornamental buildings, for their preservation from lightning.

In the evening of the 26th, a faint aurora borealis appeared in the northern horizon, behind a low stationary cirrostratus cloud, from six till nine o'clock; but no perceptible coruscations emanated from it. A hard gale prevailed from the S.E. through the evening and night.

The mean temperature of the external air this month is nearly six degrees higher than the mean of December for the last thirteen years. The nights in general were very mild,—in eleven of them the thermometer did not recede lower than 49 degrees, and they were warmer than some nights in the middle of last summer.

Although it cannot be positively asserted that comets have any direct influence in increasing the temperature of the earth's atmosphere, yet arguments may be adduced to show the probability of their having such influence when near their perihelia. Encke's comet was nearest the earth on the 14th instant, and will be nearest the sun on the 10th of January 1829.

The atmospheric and meteoric phænomena that have come within our observations this month, are five parhelia, one solar and two lunar halos, twelve meteors, three rainbows; two auroræ boreales, lightning and thunder on the 7th and 8th, and thirteen gales of wind, or days on which they have prevailed; namely, one from the North, one from the North-east, two from the South-east, one from the South, five from the South-west, and three from the West.

REMARKS.

London.—Dec. 1. Stormy. 2. Cold and cloudy. 3. Fine. 4—6. Cloudy. 7. Fine: stormy and wet at night, with much thunder and lightning. 8. Stormy and wet. 9. Fine. 10. Fine: stormy at night. 11. Stormy. 12. Cloudy. 13. Drizzly: cloudy and mild. 14. Fine. 15. Slight fog in morning: cloudy. 16. Cloudy: rain at night. 17. Drizzly: stormy night. 18. Stormy. 19. Fine: stormy at night. 20. Cloudy: fine. 21. Fine. 22. Cloudy. 23. Drizzly. 24. Fine: slight rain at night. 25—27. Fine. 28. Foggy morning: fine. 29. Foggy. 30. Slight fog in morning: cloudy. 31. Fine: drizzly.

Penzance.— Dec. 1. Fair. 2. Clear. 3. Fair: showers. 4. Misty. 5. Clear. 6. Clear: rain: 7. Fair: rain. 8. Rain: hail. 9. Hail showers. 10. Showers. 11. Fair. 12, 13. Misty: rain. 14. Fair: rain. 15. Fair: showers. 16, 17. Fair: misty: rain. 18. Showers. 19. Clear: showers. 20. Showers. 21. Misty: rain. 22. Misty: showers. 23. Fair: rain. 24. Rain: showers. 25. Showers. 26. Fair: rain. 27. Clear: rain at night. 28, 29. Clear. 30. Fair. 31. Rain: fair.

Boston.—Dec. 1. Stormy. 2. Fine. 3. Cloudy. 4. Fine. 5. Foggy. 6. Fine. 7. Stormy. 8. Fine: rain early A.M. 9, 10. Fine. 11. Cloudy. 12, 13. Fine. 14. Rain. 15, 16. Cloudy. 17. Cloudy: rain early A.M. 18. Rain and stormy. 19. Stormy. 20—22. Cloudy. 23. Fine. 24. Cloudy: rain A.M. 25. Cloudy: rain A.M. 26, 27. Fine. 28. Fine: rain P.M. 29. Cloudy. 30. Fine. 31. Cloudy.

Meteoro-

Meteorological Observations made by Mr. BOOTH at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1828.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston 8½ A.M.	London.		Penzance.		Gosport.		Bost. 8½ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.										
Dec. 1	30·314	30·215	30·00	29·95	30·18	29·82	29·22	45	27	48	47	51	35	47	NE.	N.	N.	NW.	...	...	...	...	...
2	30·475	30·313	30·25	30·20	30·32	30·25	29·98	44	32	50	42	45	41	36	NE.	SE.	SE.	calm	...	...	...	...	...
3	30·198	30·156	30·20	30·15	30·17	30·12	29·65	52	43	52	50	53	49	43	S.	SW.	SW.	NW.	0·20	...	...	...	...
4	30·289	30·190	30·20	30·15	30·22	30·18	29·65	55	44	54	51	57	51	50	S.	SW.	W.	calm	...	...	...	...	...
5	30·215	30·042	30·05	30·00	30·14	29·95	29·67	53	32	54	47	52	44	45·5	S.	SE.	SE.	calm	...	...	...	...	...
6	29·945	29·704	29·85	29·45	29·88	29·67	29·53	52	45	55	49	56	49	40	SW.	SE.	SE.	calm	·10	·09	...	0·240	...
● 7	29·629	29·572	29·65	29·35	29·67	29·42	29·07	53	44	52	47	53	45	51	SW.	SW.	SW.	SW.	...	·43	0·640	·615	...
8	29·508	29·248	29·55	29·35	29·40	29·20	28·96	48	34	47	45	52	43	44	SW.	NW.	SW.	NW.	...	·34	·840	·310	·17
9	30·028	29·727	29·90	29·75	29·95	29·63	29·24	45	35	49	42	47	41	37	W.	NW.	W.	calm	·10	...	·280	...	·60
10	30·190	30·120	30·15	29·90	30·12	30·06	29·74	50	45	53	42	54	50	37·5	W.	W.	SW.	calm	...	·05	·120	·320	...
11	30·362	29·973	30·15	30·15	30·30	29·92	29·41	54	31	54	45	53	42	51	SW.	W.	W.	W.	...	...	...	...	...
12	30·390	30·378	30·12	30·12	30·31	30·30	29·84	54	48	55	47	55	51	44	W.	SW.	S.	W.	·10	...	...	...	...
☽ 13	30·416	30·373	30·12	30·12	30·32	30·30	29·82	55	40	56	50	57	47	49	S.	SE.	S.	NW.	...	...	·285	...	...
14	30·452	30·393	30·15	30·12	30·32	30·28	30·00	50	38	52	46	50	44	49	SE.	SE.	E.	calm	...	...	...	·030	·03
15	30·305	30·204	30·05	30·02	30·20	30·14	29·93	50	45	54	47	52	47	43·5	SE.	W.	S.	SE.	·05	...	·200	·010	...
16	30·196	30·108	30·00	29·90	30·06	29·95	29·60	54	48	54	47	53	51	47·5	S.	SW.	S.	S.	...	·45	·105	·525	...
17	29·955	29·814	29·85	29·80	29·82	29·82	29·30	54	50	55	50	56	52	50·5	S.	SW.	SW.	W.	...	·09	·275	·165	·08
18	29·601	29·509	29·75	29·60	29·52	29·49	28·80	54	45	52	49	56	43	56	W.	SW.	W.	NW.	·10	·05	·600	·105	·12
19	29·948	29·760	30·12	29·95	29·94	29·78	29·11	52	47	54	44	52	50	46·5	W.	NW.	W.	W.	...	...	·300	·030	·28
20	30·035	29·988	30·12	30·12	30·03	29·98	29·42	55	49	54	48	54	52	51·5	W.	W.	W.	W.	...	...	·070	...	...
○ 21	30·105	30·070	30·15	30·12	30·07	30·04	29·50	55	48	54	52	56	49	54	W.	SW.	W.	calm	·10	...	·050	·020	...
22	30·125	30·043	30·12	30·08	30·08	29·98	29·55	56	47	55	52	57	49	52·5	W.	SW.	SW.	calm	...	.02	...	·030	...
23	30·179	29·720	29·90	29·65	29·91	29·67	29·45	52	41	54	49	52	46	47	W.	SW.	S.	calm	...	·07	·525	·320	...
24	29·675	29·445	29·65	29·55	29·58	29·41	29·17	51	40	54	48	55	43	47	SW.	SW.	SW.	calm	·10	·09	·300	·690	·05
25	29·584	29·443	29·55	29·50	29·42	29·37	28·96	46	26	48	41	47	36	43·5	E.	NW.	NW.	calm	...	...	·420	·090	.37
26	29·623	29·573	29·45	29·45	29·48	29·47	29·26	44	30	48	40	46	43	32	E.	SW.	S.	calm	...	...	·650	...	...
27	29·809	29·698	29·65	29·60	29·70	29·60	29·37	44	32	50	39	48	40	38	SE.	NW.	SE.	calm	·05	...	...	·055	...
28	30·118	29·908	30·12	29·85	30·00	29·78	29·56	45	32	50	44	49	34	37	S.	NW.	SE.	calm	...	·06	·440	·170	...
☾ 29	30·423	30·374	30·25	30·25	30·30	30·22	29·96	40	32	51	41	44	38	40	S.	W.	E.	calm	...	...	...	...	·10
30	30·398	30·271	30·20	30·15	30·30	30·20	29·92	45	36	53	49	48	45	38·5	SW.	SW.	S.	calm	..	...	...	...	...
31	30·104	29·979	30·05	30·05	30·03	29·94	29·64	49	34	50	48	52	39	42	S.	NW.	SW.	calm	·05	·03	·125	·100	...
Aver.:	30·475	29·248	30·25	29·35	30·32	29·20	29·49	56	26	56	39	57	34	44·8					0·95	1·77	6·225	3·825	1·80

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

MARCH 1829.

XXIII. *On the Junction of the Granite and the Killas Rocks in Cornwall.* *By Messrs.* Von Oeynhausen *and* Von Dechen.

[With a Plate.]

BEING in Cornwall we have paid great attention to inform ourselves about the position of the granite and the killas (argillaceous slate, hornblende slate, greenstone); never before this time having an opportunity of seeing so much of the junction between these rocks as the romantic cliffs of this county show. The granite forms several separated masses surrounded by the killas, which we have seen in all the instances overlying the former; the strata of the killas are not, generally speaking, parallel to the junction of this rock and the granite, but yet they do not dip against this junction. Between Redruth and Camborne the junction of these rocks is very well known in several mines dipping to the north with an angle less than 45 degrees. On the south of Carclase tin-mine near St. Austle, the junction between the granite and killas is nearly perpendicular, the strata of the killas underlying very rapidly to the south. The killas is mostly a well pronounced argillaceous slate of the primitive class, and very like that of Johann Georgenstadt in Saxony; but in the eastern and south-eastern parts of the county it assumes the appearance of transition slate and of grauwacke. In the immediate neighbourhood of the granite is found more hornblende slate and greenstone than common argillaceous slate. We cannot forbear to remark here, that the most part, and also the richest, of the many lodes that occur in Cornwall, both of copper and of tin, are found not very far from the junction between the granite and the killas; the parish of

* Communicated by the Authors.

Gwennap, the country between St. Day, Camborne and Helston; the parish of St. Just; the neighbourhood of St. Austle,—will give as many instances of this fact as there are mines opened in them. Even the adjacent part of Devonshire affords many instances of this rule in the rich mine of Wheal Friendship near Tavistock. The description of the different kinds of veins that occur in Cornwall, given by Mr. Carne (Trans. of the Geol. Society of Cornwall, vol. ii. p. 49), is so complete and so exact, that we have not any thing to add. We only beg leave to offer in the following lines our observations on some cases of granite veins which are found at the junction of this rock and the killas, and which we must consider as very worthy of the notice of the geologist; since they seem to throw some light on the relation of the granite to the overlying rocks.

The greatest part of the granite contains only a small portion of mica; and that may be also the reason that scarcely any rock occurs here which may deserve the name of gneiss: it consists of white or grayish quartz and felspar in nearly equal portions, and of large white twin-crystals of felspar like those of Carlsbad, which give the upper rock a porphyritic appearance. Schorl and also pinite occur very frequently in this description of granite. The colour of the felspar is in some instances reddish. This granite does not incline to decomposition; and China stone or China clay are very rarely found in it. The most striking facts of the granite veins we observed in the Land's End district, at the junction of the most western granitic mass.

I. *Mousehole.*—Near Mousehole, on the south of Penzance, the granite appears below the killas, which must be considered rather as greenstone than as slate. At low-water is to be seen the junction of both rocks dipping to the north-east; it is not an uniform plane, but protuberances of the granite pierce into the greenstone, *forming here and there a nearly perpendicular junction, although the deviation from a plane is not of consequence for the general inclination of the junction between both rocks.* A (ground) plan of this spot is represented by fig. 1. (Plate II.) Several veins of granite coming out from the main body of the granite here traverse the killas. The vein (A) is one of the largest, from $3\frac{1}{2}$ to 10 feet wide; it runs east and west, underlying rapidly to the north. The granite in it is fine-grained, has a reddish hue, a very close texture, contains only a very small portion of mica; therefore it differs in some degree from the granite of the main body, which contains large crystals of felspar: but it may be remarked that near the junction of both rocks these large crystals are sometimes wanting, and that the texture of the granite is more compact here than further from the killas.

killas. The same occurs in the veins of granite, in the middle part of which may be found larger crystals of felspar and larger masses of quartz than nearer to the walls. Small spots of killas are found in this granite vein; schorl occurs very frequently in it, as well in the compact mass as in little cells. Small open strings penetrate as well through the granite vein as through the country. The most part of the quartz veins, which may be found in every direction in the killas, stop at the walls of the granite veins; but one (*a*) traversing it appears to have changed the colour of the granite, with which it is in contact. The vein (B) is only ten inches wide, runs like the first east and west, but is nearly perpendicular; the granite in it is like that in the wide vein. Spots of killas and schorl occur also in it. Some of the quartz veins intersect this granite vein, and others are intersected by it. Several very small quartz veins, not more than half an inch thick, and running parallel, intersect the granite vein and the killas indifferently. These two veins (A and B) appear to run very far into the sea under low-water mark; near to the shore they are covered by large granite blocks. The granite vein (C) is distinctly to be seen coming out from the main body of the granite; its direction is 7 degrees from east to south; where it comes out, the main body of granite is as fine-grained as the vein itself; and, only several feet further in, appear large crystals of felspar. In a short distance from the main body the vein is intersected by a quartz vein, without being heaved. Some feet further occurs another quartz vein, eighteen inches wide, which heaves the granite vein about two feet to the left; and intersecting also the junction of the main bodies of both rocks, heaves also this junction in the same way. The direction of this vein is 15 degrees from north to east. Large masses of killas are imbedded in it as far as the country is killas. In the granite, this large quartz vein intersects other quartz veins of a different description. They are very small, being not more than an eighth of an inch thick; but very distinct, and well separated from the granite forming their wall. In some places these little veins become larger, to the width of six inches. The granite on both sides of them, to a distance of about $1\frac{1}{2}$ inch, is changed; it is of a darker colour, yellowish gray; it is harder, and contains more quartz than the rest; these little veins are to be seen on a distance of about fifty feet. Besides these veins of quartz, which have changed the appearance of their walls, there are also others running in the same direction; some of which change the granite in their neighbourhood, some do not change it. These quartz veins contain generally schorl, which we could not find in the large

quartz vein above mentioned, which also does not change the appearance of the granite, where it is intersected by it. The granite vein (C) splits into three branches; one running to the north is to be seen for some distance, another running to the south stops at a very short distance. At this place several fragments of killas lie in the main or middle branch of the granite vein. Some small open strings intersect the granite vein; and in its turn it intersects several quartz veins. Further off the granite divides into two branches, which are both intersected by a quartz vein; one of these branches ends before it reaches low-water mark, but the other is visible through a length of nearly 150 feet, and then goes into the sea. It is not more than five inches wide, and not less than two or three.

II. *Rosemodris.*—About three miles to the south-west of Mousehole is situated Carnsilver Cove, on the western side of the promontory of Rosemodris, which consists of a detached mass of killas, being merely hornblende-slate and greenstone. In this cove just mentioned occurs the junction of both rocks. The granite is rather fine-grained than large-grained, but it shows several modifications in its texture. Veins of black schorl, often two or three feet wide, intersect the granite in a nearly perpendicular position, and appear like black ribbons on the white wall of the granite. They are to be seen for the length of four or five hundred feet. Two large veins of schorl running parallel at the distance of about four feet for a considerable length, unite themselves without intersecting each other; another vein of the same constituent parts intersects both, under nearly a right angle, without heaving them. The united veins run against the junction of the granite and killas; it is to be lamented that large blocks fallen down from the cliffs hide the spot, where they must join this line. At the perpendicular wall on the east side of the cove, consisting merely of killas, there is not to be seen any trace of a schorl vein; and whether any one of the granite veins which occur here very frequently is the prolongation of this schorl vein or not, must remain doubtful. The schorl veins consist of a body of white quartz, in which the crystals of schorl occur so plentifully that at some distance it appears only black. On both walls is a string of quartz which contains less schorl than the middle part; these strings are separated from the granite by a very small interstice, which presents a colour and appearance somewhat different from the general appearance of the main body.

Fig. 2. presents a plan of Carnsilver Cove. Fig. 3. a view of the eastern wall of the cove, consisting of killas. The strata of the killas run east and west dipping to the south, forming an angle of 30 degrees with the horizon. The bottom of the cove is granite,

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of a porphyritic appearance, with large crystals of felspar; but in the distance of one foot from the junction with the killas, occurs fine-grained granite without these large crystals. The junction between both rocks is very distinct, but they hang together; and it is easy to get specimens which present both rocks in one piece. The junction of both rocks is nearly parallel to the strata of the killas, of which the lower part appears more stratified than the upper part, which is very compact. From the granite comes forth a vein (*b*) into the killas, two inches wide, consisting of a fine-grained granite like the variety of the main body of granite that occurs near the junction with the killas: no interruption is here to be seen; only an open chasm begins here, and intersects the granite as far as the bottom of the cove. The upper end of this granite vein is not to be seen. The granite vein (*c*) is a little wider than that just mentioned; it is to be seen on the whole height of the wall. An adit is wrought in it, perhaps in search of tin ore. The vein (*d*) ends at a height of sixteen to twenty feet above the main body of the granite; in the same way as does the vein (*e*). A small string runs from this vein to another (*f*), of which the upper termination is not easily to be seen. The vein (*g*) is four to five inches wide, forming in one place the shape of a hook, and will probably be seen in the upper part of the wall, which is not in the same plane as the lower part. The whole height of this vein is very nearly 250 feet above the bottom of the cove. The vein (*h*) divides into two branches. The vein (*i*) has been worked away to a considerable height, as we suppose for tin ore: we were prevented by the sea from reaching this vein and that more to the south.

These granite veins intersect some of the quartz veins that occur frequently in the killas, and are intersected by others. The component of these veins is a fine-grained granite, quite the same modification that is also found in the main body of the granite.

III. *Cape Cornwall.*—Veins of granite frequently occur in the killas near to the junction of this rock and the granite in Port Just Cove at Cape Cornwall; one of them is represented, fig. 4. It is six inches wide, runs nearly 30 degrees south of west, and dips to the south, the angle with the horizon being 49 degrees. It may be traced to a length of twenty-four feet, and a height of six feet. The strata of the killas run 7 degrees south of west, and dip with an angle of 26 degrees to the north; they are heaved by a granite vein, as will appear from a vein of quartz in the killas, and not in the regular way, but so that the *solid* forming the north wall of the vein is at a lower level than the south wall of it. The

texture

texture of the granite vein is remarkable; long crystals of schorl are disposed at a right angle on both walls of it in large grains of quartz and felspar, the interior part of the vein being filled with fine-grained granite, which contains only small crystals of schorl. Fragments of killas lie in the vein, surrounded by large-grained felspar. In the north wall of the granite vein there occurs felspar in strings and detached spots between the strata of the killas which start from the vein itself. Little hollows are found in these masses of felspar with very small crystals in them; the form of these is the four-sided prism, with the oblique face at the top parallel to the fracture. Felspar, without being separated very distinctly from the adjacent killas, occurs in it; the killas is here nothing else than greenstone.

IV. *Gew Grease.*—Serpentine and gabbro prevail in the Lizard district. What is called the Soap-rock, consists of serpentine in which are found veins of steatite having a breadth of several feet. The colour of the soap-rock is white or gray, yellowish and reddish-brown. At Gew Grease is a very deep cove, through which a brook joins the sea; it is excavated in the serpentine (fig. 5): in the bottom of another little cove joining this appears a body of granite about fifteen feet long, and visible at a height of ten feet, dipping under the serpentine towards the south (fig. 6). The granite is fine-grained, reddish, of a very close texture, and contains little spots of mica; from these it will appear that this granite is of the same kind as the granite found in the most part of the veins. This granite is commonly very hard, but it is decomposed in some instances, veins of steatite running through it. White steatite immediately covers the granite; the serpentine in the neighbourhood is partly decomposed. The larger cove above mentioned becomes very narrow before it reaches the sea, and it has here quite the appearance of the chasm of a vein (fig. 7). Here occur several veins filled with fragments of serpentine imbedded in steatite, which end before they reach the surface, although they are very wide near the bottom of the cove. Several blocks of granite are to be seen in this place, but it remains doubtful whether they are *in situ* here, or whether they fell into this chasm from above.

V. *Kynance Cove.*—Kynance Cove is situated near Gew Grease, on the south of this place. The walls of it consist of a very fine dark serpentine with diallage. A vein of granite intersects here the serpentine (fig. 8.); it runs nearly east and west, dipping a little to the north; it looks like a brick-red coloured ribbon on the black wall of the serpentine. The breadth of the vein may be about three feet and a half; the height to which it is visible may be nearly thirty feet. The granite

granite near to the hanging or north wall is hard, but nearer to the south wall it becomes more and more decomposed. Several strings of granite start from the main vein into the south wall, and end at a short distance. The north wall of the granite is formed not by the serpentine, but by a vein of steatite two feet and a half wide. The granite of the vein is fine-grained, and of the same description as in the other granite veins.

VI. *Kennick Cove.*—On the eastern shore of the Lizard district is situated Kennick Cove, near the village of Gwendra. The prevailing rock is a serpentine of a close texture, of a dark colour, either reddish-brown or black, containing fine diallage in large spots; in it occur veins of granite, greenstone, and steatite. The vein of compact greenstone appears at the cliffs near (*a*) fig. 9, and a section of it is represented by fig. 10. This vein is five feet thick, runs 30 degrees west from north, dipping to the north-east with an angle varying between 25 and 45 degrees. In both walls of it are found strings of steatite, and a string occurs in the hanging wall, one foot wide, filled with fragments of greenstone cemented by steatite. A very fine vein of steatite occurs not very far from this greenstone vein (fig. 11). It is at the bottom five feet wide, and it may be distinctly seen that it ends at the height of fifteen feet. An earthy grayish substance is found forming both walls of the vein, to the thickness of two inches and a half; it contains a large portion of asbestus, so that the whole takes a fibrous appearance. The steatite in the vein is of a grayish hue, which evidently is derived from a great many little gray spots imbedded in the mass, in the same manner as the spots of mica in the granite of the veins. This gray steatite is intersected by many strings of a very white steatite. In the dark serpentine forming the country of the vein occur frequently asbestus, calcareous spar and talc, in little strings.

No veins are found in the coves (*c*) and (*d*); the sand here appears to contain grains of titanium. A considerable mass of greenstone (fig. 12), intersected by strings and irregular masses of granite, occurs near the cliff (*e*). The granite and greenstone are intimately joined together; the strings and veins of granite do not hang together with the walls of greenstone, but the masses of granite are so intimately mixed with the greenstone, that they cannot be separated one from the other. This mass of greenstone and granite appears to be stratified; the strata run 15 degrees south from east, dipping to the south with an angle of 45 degrees. The serpentine lies undoubtedly below this strange rock. Veins of white steatite occur near the junction of both rocks, which are covered by decomposed granite,

granite, of a reddish colour. A row of rocks, from (*e*) to (*f*), runs out from the shore into the sea, consisting only of granite and greenstone; the cliffs do not show any thing else than serpentine. Both rocks enter the cliffs at the point (*f*), and appear to continue further.

A vein of granite, six feet wide, appears in the cliffs near (*g*); it is of the same nature as the granite of Gew Grease (fig. 13). A great many strings of asbestus there intersect the serpentine. Veins of steatite are in both walls of the granite. Another granite vein (fig. 14.) more remarkable, occurs near (*h*); at the bottom it is six feet wide, higher up less wide, so that its termination is very distinct: steatite continues to fill the vein in the upper part; but this also ends, before it reaches the surface, in a mere string; the total height of the rock may be nearly sixty feet. A vein of steatite one foot and a quarter wide starts from this vein; it lies nearly horizontally, and may be traced to a distance of thirty or forty paces without meeting with the end of it. This vein is heaved twice by strings filled only with earthy talc. Veins of asbestus, commonly the last ends of veins of steatite, are found very frequently. A vein of granite and greenstone occurs at (*i*), of a width more than eight or ten feet. A granite vein three feet thick is found near (*k*); it appears to intersect the country in a position nearly horizontal. All these veins may be said to start out from the mass of granite and greenstone, which forms the rocks in the sea from (*e*) to (*f*). The number of granite veins which are found in the serpentine between the shore and the village of Gwendra is very great.

Between Gwendra and Coverack, which is about six miles distant, occurs the junction of the serpentine and the gabbro. The whole country is covered with large blocks of the latter rock, the white appearance of which shows from a distance the line of junction between both rocks. These rocks are like those found at the Baste in the Hartz.

VII. *Cligga Point.*—Cligga Point is situated a couple of miles to the north-east of St. Agnes. From this town to the promontory occurs nothing else but killas. Near to the promontory at (*a*) fig. 16. is found a rock, which may be considered as a kind of granite; it chiefly consists of quartz, which frequently occurs here in double six-sided pyramids. Felspar and mica occur only in a small proportion in it, but schorl is more abundant. This rock is decomposed near to the surface; the crystals of quartz cover the surface; but at some depth it becomes harder, and it is a well pronounced granite at the point (*b*); felspar occurs more frequently in it, partly in a fresh state, partly decomposed into China clay. Rocks of granite are

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to be seen at (*b*); the grains in it are of a common size; the felspar is of a white colour, inclining to decomposition; twin crystals of a larger size lie porphyritically in the rock. The quartzose rock above-mentioned is very like the granite in the neighbourhood of some quartz veins at Mousehole; *and really the same fact occurs also here.* The granite at the point (*b*) is frequently intersected by strings of quartz, and their walls consist of the same quartzose rock. A very well characterized killas is to be seen on the eastern side of Cligga Point; it is of a gray and greenish colour, sometimes with little red points like the clay slate in the neighbourhood of Viel-salm in the Ardennes. Several tin lodes have been worked here; they run east and west, dipping to the north, but nearly perpendicular. Wolfram is found very frequently on the old heaps, and a little yellow copper ore and tin ore.

The junction of killas and granite may be readily observed near (*d*); the killas has here the appearance of a very fine-grained gneiss.

A perpendicular wall more than one hundred feet high is formed by the granite at (*e*); numberless veins of granite here intersect the granite itself; the granite in both walls of each is harder and more quartzose than the other; these veins run very parallel, and dip all to the north; they give a stratified appearance to the rock. Quartz veins like these occur very frequently here in the granite. This phænomenon is in no point so perfectly exposed to observation as near (*f*). Frequent quartz veins running east and west, dipping very nearly perpendicular to the north, intersect here the granite at distances of from one foot and a half to three feet. The walls consist of a rock, exactly the same as occurs between the points (*a*) and (*b*). The granite appears stratified, the strata having the thickness of the interstices between the quartz veins, which are only a quarter of an inch wide. The granite which is not in contact with these veins inclines to decomposition, but on the contrary the walls of the veins are very hard. In these quartz veins is found tin ore and wolfram; they are therefore of the same nature as the granite veins in the killas near (*c*); they are even parallel to them, and differ only by being very small. Two quartz veins of a very different kind intersect the granite at *f* without heaving; they are four inches wide, run 15 degrees to the west from north, dipping with an angle of 85 degrees to the west. The quartz they contain is milk-white, and separated by fissures perpendicular to the walls of the veins; the granite forming the walls of these veins does not differ from the other; these veins do not contain any metallic

substance. The wall opposite to that now mentioned (*g*, fig. 19), appears to be killas. The extreme steepness prevented us from reaching this wall itself. A great many old levels are to be seen in it, which appear to have been driven for the purpose of raising tin ore. The granite is below the killas in the cove (*h*, fig. 19). A layer, sometimes two inches thick, is found at the junction of both rocks (near *i*, fig. 20), consisting of very small but angular fragments of killas; large blocks of killas occur here imbedded in the granite. The granite inclines very much to become decomposed, only at (*k k*) it is fine-grained, harder, and partakes of the appearance of porphyry (elvan); these places are not of great extent.

The Beacon of St. Agnes consists of those varieties of killas which are commonly found in the immediate neighbourhood of the granite. On the west side of the beacon occurs a quartzose rock like that near Cligga Point; frequent pyramids of quartz cover the surface; clay is raised from a great many shallow pits; certainly the granite may not be far below this place. We do not know whether the cliffs on the north and west sides of the beacon exhibit any fact which may confirm or contradict this opinion.

[To be continued.]

XXIV. *On an Electrical Phænomenon.* *By the Rev.* J. B. Emmett*.

HAVING constructed an electrical machine of uncommon magnitude and power, an accidental circumstance led to the discovery of a singular development of electricity. The floor of the room in which the machine was placed being very dry, I had occasion to have a wire of considerable length attached to the cushion. My friend, Mr. Harwood of York, first noticed a particular crackling sound to be emitted from the wire, whenever a spark flew round the globe of the machine: on darkening the room, whenever a spark flew from the prime conductor to the cushion, the whole of the wire was found to be beautifully illuminated, throwing off, from points about $\frac{1}{8}$th or $\frac{1}{10}$th of an inch asunder, a number of distinct and separate pencils of electric light, to the distance of $\frac{3}{4}$ths of an inch. The wire first used was of copper, and about $\frac{1}{20}$th of an inch thick; but being desirous to ascertain to what distance the effect might be extended, I substituted fine silver wire, not more than $\frac{1}{80}$th of an inch, and between 70 and 80 feet in

* Communicated by the Author.

length,

length, which was kept close to the floor of the room by weights, at the distance of 10 or 15 feet from each other. As before, the whole length was illuminated; and the streams of electric light were as long, but not quite so brilliant, as when the shorter wires were used.

Being fully satisfied as to the fact, I requested a number of my scientific friends to examine the phænomenon: in their presence, the following facts were ascertained. The cushion being insulated by a glass pillar two feet long, the wire attached thereto is illuminated at every spark which passes round the globe, when in contact with the floor of the room: the light is always white: it was extended along the whole of any length of fine silver wire which we could make use of, and which we used to the extent of about 80 feet. If a conducting substance be brought within about $\frac{1}{2}$ an inch of any part of the wire, whenever the wire is illuminated a very pungent and dense spark is obtained: if the wire be connected with the gold-leaf electrometer, at every illumination of the wire a dense spark passes from the leaves to the tin foil; the leaves are scarcely separated, nor are they violently agitated; a very trivial undulation alone being observed, although the spark emitted was at the least $\frac{1}{2}$ an inch long. Next, the wire was insulated by being attached to glass rods, placed at sufficient intervals from each other. The wire was always negatively electrified; and since a star of light appeared at the end of the wire, we were certain that the insulation was good; the wire being about 80 feet long: the illumination took place, as before, at every spark which flew round the globe. On presenting the finger towards any part of the wire, a stream of electric light was seen between them (the wire being highly negative); but, as before, at the moment of a spark, a very dense spark passed between the wire and the finger: the effect upon the electrometer could not be so well observed as when the uninsulated wire was used; for on bringing it sufficiently near to the wire, the leaves were permanently open and considerably agitated; yet at every spark, one passed from one of the leaves to the tinfoil without injuring or agitating the leaf.

I do not hazard a conjecture respecting the cause of this phænomenon: however, the electricity seems to be in the same condition with that observed by Dr. Priestley, which he denominated the lateral explosion.

The machine with which these experiments were made, consists of a globe of what the workmen term black or common bottle glass; its diameter is about 18 inches: the conductor is 3 feet long, and 6 inches in diameter: the spark measures about 12 inches, when the machine is pretty well excited;

when the excitation is very good, the spark is much longer. This glass, as Dr. Priestley observed, is more powerfully excited than the finer sorts, and its power is but little affected by a moist atmosphere.

XXV. *On the Action of Steam and Quick-lime upon heated Galena.* *By Mr.* H. L. Pattinson, *Alston, Cumberland.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

PERHAPS nothing has contributed more to the great advancement of knowledge within the last few years, than the rapid exchange and diffusion of information among scientific and practical men by means of periodical publications. Opportunities are offered of putting facts upon record without difficulty or delay; and although some communications may possess a greater degree of interest than others, yet there is probably no one in which well-ascertained facts are correctly stated, which remains without its use at some period or other. I am induced by these considerations to send you an account of two experiments which I lately made on the reduction of galena.

Experiment 1.—An earthen tube 18 inches long and $\frac{3}{4}$ths of an inch internal diameter was properly coated, and made to traverse a furnace in which ten inches of the middle could be highly heated. To one end was attached a bent tube terminating in a pneumatic trough, and to the other a retort containing water made to boil by the flame of a lamp. One thousand grains of very pure cubical galena were wrapped up in a cylinder of paper, and pushed to the middle of the tube when very hot; and over this was transmitted a current of steam. A copious stream of sulphuretted hydrogen gas was emitted, and the water in the pneumatic trough became as white as milk, before the operation was concluded: no precipitate was deposited from this water after standing twenty-four hours, it was still milky and turbid. The process was continued an hour; and during the whole time gas of the same kind was given off, but slowly towards the conclusion.

On breaking the tube after cooling, it exhibited the following appearances.

a. A cake of fused and partly reduced galena, flat on the upper surface, and having the form of the tube below, occupied three inches of the tube nearest the retort from which the steam issued. This mass was brittle; it could be cut with a knife, but not a particle of metallic lead was observable. This substance was most probably a sub-sulphuret of lead.

b. Six

b. Six inches of the middle of the tube was quite empty, excepting a small number of brilliant cubical crystals, which seemed to be a portion of sublimed galena.

c. Three inches of the end of the tube connected with the trough was nearly filled with sublimed galena, beautifully crystallized in cubes of considerable size, and having a very splendid appearance. These crystals broke again into other cubical fragments having very brilliant faces, and in this respect exactly resembled the original ore before being subjected to heat. A small quantity of ore was deposited in the coldest part of the tube, near the end projecting from the furnace, in the form of a fine blueish-gray powder without cohesion. Not a particle of true metallic lead was produced by the operation.

Experiment 2.—Another tube was coated and arranged exactly as in the last experiment. Nine inches of the portion nearest the trough were filled with pieces of recently burnt lime, each about the size of a pea; and when heated to whiteness, 600 grains of galena were introduced into the end of the tube to which the retort was attached; and after being sufficiently heated, it was carried through the highly incandescent lime in the state of vapour, by a current of steam. During the process a large quantity of sulphuretted hydrogen gas was given off, but the water in the trough never became so milky as in the last experiment.

On opening the tube at the end of the operation its appearance was as below.

d. All the galena was expelled from the end into which it was introduced, no portion whatever remaining.

e. The lime in the middle of the tube exhibited the same appearance as when introduced, excepting one or two pieces which had acquired a yellow colour on the surface; but this yellow colour did not penetrate to any depth; and if occasioned by the formation of sulphuret of lime, its quantity must have been very inconsiderable.

f. A few pieces of lime towards the end of the tube had apparently imbibed a portion of galena; as they had acquired weight considerably, and exhibited a steel-grained fracture when broken. The colour of these pieces on the outside was a fine dark indigo blue.

g. Towards the extremity of the heated part of the tube, a quantity of the ore operated upon was deposited in a crystalline form as before; but its colour was externally a very dark indigo blue, differing in this respect from that deposited in the first experiment.

h. A quantity of ore was found in the form of a grayish black powder as before, near the end of the tube.

i. Some

i. Some small drops of fused ore, which very much resembled the imperfectly reduced ore of *a* in the first experiment, occupied the bottom of the tube immediately at the end of the lime; but there was not a particle of pure lead formed in any part of the tube.

k. Four hundred grains of the gray-coloured lumps described in paragraph *f*, were assayed with borax and tartar; and a button of lead weighing 138 grains was obtained. From this lead a small globule of silver weighing $\frac{53}{1000}$dth grains was extracted by cupellation, which is after the rate of 13 oz. 3 dwts. 10 grs. per 21 cwt. avoidupois of lead, and is not more than might be expected from the sample of galena submitted to experiment.

From these experiments it appears, 1st, that the vapour of water is decomposed by transmission over heated galena, its hydrogen uniting with a portion of the sulphur to form sulphuretted hydrogen gas, and its oxygen combining with the equivalent quantity of galena to form sulphate of lead, to which the milkiness of the water in the two experiments is to be attributed. The galena, which gives up a portion of its sulphur to form sulphuretted hydrogen gas, is probably reduced to the state of sub-sulphuret of lead. 2ndly, Quick-lime is used in the large way to reduce the slags or scoriæ from lead ore into a pasty state, so that they can be more easily removed from the hearth or furnace; but it appears to have a very inconsiderable effect in promoting the reduction of galena; and hence the quantity used should be no more than may be sufficient to effect the purpose for which it is applied. 3rdly, The deposition of galena from its vapour in contact with steam in a highly crystalline form is an interesting circumstance. The crystals exactly resembled in appearance many specimens from the numerous lead-ore veins traversing the mountain limestone of this district, and might warrant at least the conjecture, that galena in these veins has been in some instances supplied by sublimation from below. I am, Gentlemen, yours, &c.

Lowleyer-Alston, Jan. 13, 1829. H. L. Pattinson.

XXVI. *On the Curvature of Spirit-Levels.* *By* J. Nixon, *Esq.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

SOME years ago I received from Mr. Dollond four ground spirit-levels (unmounted), of which two served to replace the much less sensible original levels of the horizon-sector alluded to in Phil. Mag. and Annals, vol. iii. page 190. The tubes

tubes were about six inches long, nearly half an inch in diameter, slightly conical, and their bubbles were estimated to move the one-fortieth part of an inch for a variation of inclination equal to one second.

Conceiving that the reversing points of the levels of the horizon-sector might be more immediately and correctly ascertained from scales of equal parts attached to the tubes, than by determining from measurements on the graduated arcs the situation of these points relative to the fixed marks drawn on the surface of the tubes, it became necessary to verify the estimated curvature of the levels. In the accomplishment of this object, the sector afforded singular facilities; but as the manipulation of the instrument may not be generally understood, I prefer pointing out the method by which the level of the telescope of a good theodolite may be mounted with a scale, and the angular value of its divisions obtained.

For the scale, cut a piece of moderately stiff paper into the form of a parallelogram of the proper length, and about a quarter of an inch wide, and press it evenly upon the glass tube, previously spread over with liquid glue, with either of its longitudinal edges laid exactly upon the line of curvature or straight line passing (in the direction of the axis of the tube) through the middle points of the two bubble-marks. When the scale is quite dry, divide this edge into minute equal parts, and number them from zero, placed at that end of the scale the nearest to the eye-piece of the telescope, progressively to the other extremity.

To find the angular value of the divisions, set up and fix the theodolite in a situation inaccessible to the direct rays of the sun, and adjust the instrument for observation with the divided edge of the scale perpendicular to the optical axis of the telescope, and with the zero of the vertical arch in a line with that of its vernier. Having clamped the horizontal circles with the telescope *exactly* over two (opposite) screws of the parallel plates, make use of these screws to force the bubble of its level to the zero extremity of the scale. When at rest, register in one column, which designate, "telescope depressed," the distance of each end of the bubble from the zero of the scale. The bubble being moved, in the next place, by the aid of the tangent-screw, or rack-work of the vertical arch to the other extremity of the scale, note the distance from zero of each of its ends, and enter them in a separate column to be termed, "telescope elevated." Half the difference of the sum of each column is evidently the space traversed by the bubble, of which the corresponding angle (of elevation) will be given on the vertical arch. To insure to the measurements the requisite

quisite degree of accuracy, it will, however, be necessary, as an error of one minute might be committed in the graduation of the arc, or in the reading off, to continue the operation of first depressing the telescope by the same screws of the parallel plates, and of subsequently elevating it by the tangent-screw of the vertical arch, noting in the proper column after every depression or elevation of the telescope the distance of the ends of the bubble from the zero of the scale, until a sufficient multiple of the mean angle shall be obtained. Lastly, find the sum of each column, and divide the angle read off the vertical arch by *half* their difference, which will give the value in seconds of one division of the scale. The original scale may now be taken off, and the one substituted, divided into equal parts of one second each. A black-lead pencil being used in marking and numbering the divisions, the whole may be varnished over to prevent obliteration, &c.

The reversing point of a similar level will be equal to one-fourth of the sum of the divisions from zero of the extremities of the bubble noted before and after reversing the telescope within its Ys. Temporary reversing marks may be conveniently made on the tube with a camel-hair pencil dipped in white water-colour; each mark being equidistant from the division, answering to the reversing point by half the length of the bubble. In addition to the facility and accuracy with which minute vertical angles may be measured on a similar scale, it would be found particularly serviceable in a novel method of levelling, of which I shall beg leave at some future opportunity to transmit a notice.

The two levels of the horizon-sector are mounted in brass cases, in which, as the telescope requires to be inverted at every other observation, they are necessarily fitted as closely as practicable. Each division of the scale of forty to the inch, was found from repeated trials with the sector, to be $1''{\cdot}906$ in the right-hand level, and $2''{\cdot}124$ in the other; or *double* the estimated value. As the (glass) tubes are slightly flexible, I suspected that their curvature might have been augmented in the mounting, and made the following experiments with the shortest of the two spare levels, with a view to gain information on the subject.

Experiment I.—Two Ys, cut out of a mahogany board 0·1 inch thick, were glued to the upper surface of an inflexible bar of oak laid securely on the cylinder of the sector. The short level furnished with a scale was then placed quite loose within the Ys, each end overhanging its Y by one-third of the length of the tube. The space traversed by the bubble of the short level being compared with that passed over by the bubble of one

one of the levels of the sector, the variation of inclination being the same for both levels, it appeared that one division of the scale of the former, also of forty to the inch, was equal to $1''{\cdot}480$*. (In this and the following experiments, the axis of the short level was invariably made parallel to that of the sector level, the line on which the divisions are drawn being perpendicular in the two levels to their respective axes. As neither of the levels might be uniformly curved throughout, they were rendered strictly parallel in horizontal inclination; and care was taken never to drive the bubbles completely to the extremities of the tubes. The values quoted are the mean of three or four satisfactory measurements of about $100''$ each.

No. II.—The Ys being thinly coated with glue, the level was placed gently within them in the preceding position, and suffered to dry without pressure. The divisions were then found to be $1''{\cdot}683$ each.

No. III.—The level was placed on the even surface of one of the brass indices of the sector previously spread over with glue, and left to dry. The divisions were now $1''{\cdot}679$ each.

No. IV.—The level being glued to the surface of a mahogany bar, eight inches long by one inch square, fixed to the cylinder of the sector, the divisions, after a lapse of a couple of days, were found to be $1''{\cdot}854$ each. On repeating the measurement on the following day, the value appeared to be $1''{\cdot}853$.

No. V.—The level was mounted in a brass case with a degree of tightness barely sufficient to preserve it unvaried in position.—Value of one division $= 1''{\cdot}684$.

No. VI.—The level being loose within the case, the packing (with cotton wool) was confined to the ends of the tube.—Value of one division $= 1''{\cdot}915$. It must be supposed that the mere pressure of the packing had distorted the tube; otherwise, why did the curvature differ from its value in the first experiment?

No. VII.—The level was placed, unattached, within the mahogany Ys, overhanging two inches at the smaller end of the tube, and scarcely half an inch at the opposite end.—Value of one division $= 1''{\cdot}615$.

No. VIII.—The Ys being set up more distant from each other, the level, placed within them unattached, extended at each end no more than a quarter of an inch beyond the Ys. —Value of one division $= 1''{\cdot}703$. The mere weight of the level, it would appear, had not diminished the degree of curvature.

* The mean of four preceding measurements, rejected on account of a slight difference in the degree of inclination of the two levels, gave $1''{\cdot}479$ for the value of one division.

Although the differing results of the experiments afford little satisfactory explanation of the causes of the variations in the curvature of the levels, and one or two might have been differently anticipated, they amply serve to prove that the mounting tends to render them less sensible, and point out the necessity of verifying the accuracy of the scales furnished by the artist.

Leeds, Dec. 20, 1828. J. Nixon.

XXVII. *Analysis of an aluminous Mineral in the Collection of the Yorkshire Philosophical Society. By the Rev.* William V. Vernon, *F.R.S. F.G.S. Pres. of the Yorkshire Philosophical Society**.

THE calcareous rock on the coast at Scarborough, which Mr. Smith considers as corresponding with the great oolite of Bath, is covered by beds of sandstone much marked with oxide of iron. Whilst I was examining these beds in 1826, my attention was attracted by a mineral†, with which they are in many parts veined, of a white colour, but not bearing, to my eye, the appearance of calcareous spar. Finding that this substance had the property of adhering strongly to the tongue, I conceived it to be probably aluminous, and presented a specimen under that character to the Yorkshire Philosophical Society, after having ascertained that sulphuric acid and potash converted the greater part into alum. I have lately examined it more accurately, and find it to differ from any of the aluminous minerals which have been yet described.

The mineral when pure is perfectly white, without lustre, with a conchoidal fracture, easily scratched by the knife, and polished by the nail; it is highly adhesive to moist surfaces; when breathed upon, it has a strong earthy smell; when put into water, it does not become translucent nor fall to pieces, but gains considerably in weight. The absolute specific gra-

* Communicated by the Author.

† In the account of these beds prepared by Mr. J. Phillips for his forthcoming publication on the Geology of Yorkshire, the veins here mentioned are thus described: "The calcareous and irony strata (great oolite, Smith) have their long straight intersecting fissures often lined with double laminæ or septa of oxide of iron, between which sometimes occurs a white compact, soft, smooth substance, which the Rev. W. Vernon has ascertained to be a new aluminous mineral; exactly similar septa, and occasionally the same aluminous substance occur in the superincumbent variable beds of sandstone; and in addition, this bed presents a number of ochraceous belts or zones parallel to the margins of the blocks, and beautifully variegating the blue or white colour of the stone."

vity

vity of such a mineral cannot be fixed; because it contracts in bulk when exposed to a strong degree of heat, and when dried at lower degrees its weight is in proportion to the temperature employed; nor is it easy to ascertain the amount of absorption which takes place when it is weighed in water. Having left it for some time in a dry atmosphere at about 60° of Fahrenheit, I found that it lost in distilled water 0·57 of its weight; the gain by absorption appeared to be 0·16. The specific gravity calculated from these data is 1·485.

Having in a preliminary examination of the mineral detected nothing in it but alumine, with a little silex and a minute quantity of iron, I proceeded to analyse it in the following manner:—

Two grains, having been ground, were treated with nitric acid till they were dissolved, except a small portion which remained in gelatinous flocks; the whole was then dried, and on resolution in dilute acid, silex was left behind, the weight of which, after ignition, was 0·21 parts of a grain.

A drop of the solution was tested with nitrate of barytes, but no trace of sulphuric acid was discovered.

The alumine was precipitated with bicarbonate of potash, and after its precipitation nothing was found in the residual liquor. The precipitate was treated with a solution of pure potash, and all dissolved but 0·005 parts of a grain, which appeared to consist chiefly of peroxide of iron. The alkaline solution was saturated with acid, and precipitated by carbonate of ammonia; the precipitate, washed by decantation, was dried and strongly ignited; it weighed 0·85 parts of a grain.

To ascertain the proportion of water, 0·62 grains of the mineral in a similar state of dryness were strongly heated; the loss of weight was 0·29, or in two grains 0·935.

The sum then of the analysis is as follows:

Alumine	0·850	or	42·50
Silex	0·210		10·50
Water	0·935		46·75
Peroxide of iron	0·005		00·25
	2·000		100·00

I should not pretend however to determine the proportions, even in so simple a combination, from the small quantity which was here employed, without repeating the experiments; and I made therefore another analysis, with this variation in the method pursued; that after ascertaining the quantity of water by exposing eight grains of the mineral to a white heat, I ignited them with pure potash, and brought the whole into solution in muriatic acid.

The result of this analysis gave

Alumine	42·75
Silex	07·90
Water	48·55
Peroxide of iron	00·80
	100·00

If this be taken as the more correct determination, the substance may be considered as a silicate of alumina, in which the alumina is rather more than five times the weight of the silica. Klaproth and Berthier have analysed two minerals, the one called Kollyrite, the other, siliciferous hydrate of alumine, in both of which the alumina is about three times the weight of the silica; and there is a mineral called Allophane, and another called Lenzinite, in which it appears, from the analyses of Stromeyer and Dr. John, that the proportions of these elements are nearly equal, the weight of the alumina in allophane being somewhat greater than that of the silica. The atomic weights of alumina and silica are not perfectly settled; but it is evident that they do not differ widely from each other, and that the atom of alumina weighs rather more than the atom of silica. It is probable, therefore, that in the two last of these minerals, one atom of silica is combined with one of alumina; that in the minerals analysed by Klaproth and Berthier, one atom of silica is combined with three atoms of alumina, and that, in that now described, one atom of silica is combined with five atoms of alumina. Should this view of its composition prove to be correct, it will require a separate mineralogical name, and may be distinguished by the appellation of Scarbröite.

XXVIII. *Réflexions sur un Mémoire de M.* T. N. Nicollet, *inséré dans la* Connaissance des Tems *pour l'An* 1831, "*Sur un Nouveau Calcul des Latitudes de Mont-Jouy et de Barcelone, pour servir de Supplément au Traité de la Base du Système Métrique**."

IL y a long tems que l'on connait le phénomène assez étrange, que les observations des latitudes faites en 1792, avec un soin extrême avec des cercles-répétiteurs de Lenoir, par Méchain, à Mont-Jouy, et l'année suivante à Barcelone, ont donné une amplitude de l'arc du méridien plus forte de $3''{,}24$, qu'elle ne devrait être suivant la distance géodesique très-bien con-

* Communicated by a correspondent.

nue,

nue, de ces deux points, et qui n'est que de 950 toises dans la direction du méridien.

En vain on a essayé, jusqu'-à-présent de rendre raison de cette différencé d'une manière plausible. On l'a d'abord attribué à l'imperfection des instrumens, et M. Méchain, tout le premier, était de cet avis. D'autres l'ont cherché dans un défaut d'attraction vers la mer, ou dans une attraction plus forte vers les terres, qui sont au nord de Mont-Jouy, qui y avaient attiré le fil-à-plomb, ou la liqueur des niveaux, et auraient déplacé le vrai zenith. Mais toutes ces explications n'étaient que des hypothèses impossibles de prouver; par conséquent, ce phénomène est toujours resté inexpliqué d'une manière satisfaisante.

L'éclaircissement de ce fait singulier est cependant très-important, puisque tout le merite, et toute l'utilité de ce grand travail de la mesure de l'arc du méridien compris entre les parallèles de Dunkerque et de Barcelone, prolongé ensuite jusqu'aux îles Baleares, en dépendent.

M. Nicollet, dans son mémoire, lu à l'Académie des Sciences le 10 Mars 1828, et inseré dans les Additions à la *Connaissance des Tems* pour l'an 1831, tache d'expliquer et même de concilier cette différence. Il croit prouver (pag. 76) " que les anomalies qui ont tant inquieté les célèbres auteurs de la *Base du Système Métrique*, ne peuvent être imputées ni à l'observateur, ni à l'attraction dépendante des irrégularités locales de la terre. Comme on l'a vu, la cause en était tout simplement dans l'imperfection de nos connaissances."

M. Nicollet prétend faire voir, que les déclinaisons des étoiles employées dans le calcul de ces latitudes, étaient affectées d'erreurs de 3 à 4 secondes, et qu'en adoptant les nouvelles déterminations plus exactes, l'erreur disparaissait, et que la fameuse différence de $3''{,}24$ qui avait tant intriqué les astronomes, se réduisait à $0''{,}21$.

Voyons de quelle manière M. Nicollet arrive à cette conclusion. Il présume d'abord que M. Méchain avait ignoré que l'étoile ζ de la Grande Ourse, qu'il avait observé tout à Mont Jouy qu' à Barcelone, était double, et que par conséquent l'astre, sur le quel il avait pointé sa lunette, n'était pas la grande étoile, mais un point intermédiaire, un centre apparent des lumières entre la grande et la petite étoile. Voici, comme M. Nicollet s'explique à ce sujet.

..... " Le souvenir du rôle facheux que cette étoile joue dans la mesure du méridien, et la connaissance que j'avais de sa nature multiple, m'ont fait présumer qu'il était possible que M. Méchain eût ignoré cette dernière circonstance. Dés lors, j'ai dû rechercher quelles pouraient être les consequences de l'ignorance

l'ignorance d'un tel fait, et profiter de cette occasion pour calculer de nouveaux les latitudes de Mont-Jouy et de Barcelone, afin de les mettre au niveau des progrès qu' ont faits, depuis le commencemeut de ce siècle, les branches de l'Astronomie qui s'y rapportent. ζ de la Grande Ourse est composée de deux étoiles, l'une de 3^{e} et l'autre de 6^{e} grandeur, ayant entre elles une distance angulaire de 14″ en arc, et, la plus petite étant placée au sud de la principale, avec une différence en déclinaison de 11″ à 12″. MM. Méchain et Delambre paraissent réellement de l'avoir passée, du moins je n'ai pu découvrir, ni dans l'ouvrage de la Méridienne, ni dans leurs manuscrits originaux déposés aux archives de l'Observatoire Royal, ni dans les écrits nombreux où M. Delambre a eu l'occasion de révenir sur ces anomalies, qu'ils en eussent fait mention. Il faut des lunettes d'un grossissement assez fort pour distinguer les deux étoiles, celle des cercles répétiteurs ordinaires que j'ai vus ne peuvent en opérer la séparation. Nous n'avons pas à notre disposition la cercle sexagésimal dont M. Méchain s'est servi pour cette étoile, il l'a cédé aux astronomes de Milan, avant sa rentrée en France ; mais nous possédons, à l'observatoire, le cercle No. IV. de M. Delambre, et l'on sait que les quatre instrumens repartis entre les observateurs différaient assez peu entre eux en dimensions pour que celui-ci puisse, à quelques égards, servir à la vérification d'un fait de cette nature. Or, la lunette du cercle No.IV. étant dirigée sur ζ de la Grande Ourse, ne laisse voir qu' une étoile simple, dont la forme est, en général, moins bien terminée que celle des étoiles qui sont uniques, et du même ordre de grandeur. Cependant, la compagne de ζ, si elle était isolée dans l'espace, est une de celles qu' une bonne vue distinguerait sans aucun succours ; mais sa proximité d'un point lumineux beaucoup plus brillant qu'elle confond les deux lumières en une seule, tant que leur distance apparente n'est pas assez amplifiée pour les rendre distinctes. Il resulte de là que le point observé par M. Méchain a dû être un centre apparent compris entre les deux étoiles, mais placé plus prés de la Grande que de la Petite. Il n'est pas nécessaire de savoir dans quel rapport exact ce centre partage leur distance mutuelle ; il suffit ici de réconnoitre le sens de l'altération. Or il est evident que son effet a eté de rendre trop grandes les distances zénitales prises dans les passages inférieurs, et trop petites celles des passages supérieurs....."

Ici, M. Nicollet entre dans une longue discussion, pour savoir si l'étoile ζ de la Grande Ourse, " était réellement double, au tems où M. Méchain l'observa." Les observations, dit-il nous ont appris que ces étoiles, physiquement doubles, ont une dépendance mutuelle, qu'elles s'attirent réciproquement,

et

et qu'elles forment un système propre qui tourne autour de son centre commun de gravité, la plus petite étoile faisant sa révolution de la plus grande. Ces systèmes sont donc susceptibles d'offrir, à des longs intervalles, le phénomène curieux de l'éclipse d'une étoile par une étoile. Le durée de ces éclipses parait fort longue, et cela s'explique par la lenteur de le révolution apparente de l'étoile satellite autour de la principale. Les astronomes modernes ont déjà rencontré les principales variétés de ces phénomènes; Herschel n'a pu revoir les compagnes de plusieurs étoiles qu'il avait antérieurement reconnues positivement doubles; tout récemment encore, on a fait de vains efforts pour découvrir les satellites de ζ d'Hercle et de δ du Cygne, notées comme multiples depuis long tems; enfin, d'autres étoiles, telles que ζ d'Orion, qui étaient simples, sont devenues doubles. Il importe donc de réconnaitre à la quelle de ces deux espèces d'étoiles multiples ζ de la Grande Ourse appartient, pour savoir si elle a pu présenter l'éclipse de sa compagne à Mont-Jouy et à Barcelone..... Une semblable observation, (continue M. Nicollet) n'a encore été faite q'une fois, que je sache; et parmi tant d'étoiles qui auraient pu y donner lieu, le hasard a voulu q'elle tombât précisement sur celle que nous occupe. Voici la note qu' on lit dans la *Connaissance des Tems* de l'an IX. (1802) p. 360; elle est de M. Flaugergues, dont le nom n'est pas sans autorité en astronomie:

" ' J'ai observé autrefois et souvent l'étoile qui est au milieu de la queue de la Grande Ourse, marquée ζ par Bayer, parceque je jugeais par la distance apparent de cette étoile à Alchor, de la force des lunettes que je voulois eprouvir, mais je ne m'étais pas apercu que cette étoile fût double. Le 4 Août 1787, à 8^h du soir, regardant cette étoile avec un telescope de 15 pouces, je vis avec surprise qu' elle étoit composée de deux étoiles, une grande et l'autre petite, distantes entre elles du diamètre de la plus petite.....

" ' Depuis cette époque, ajoute M. Flaugergues, j'ai observé souvent ces deux étoiles, et j'ai reconnu que la distance entre elles augmentait continuellement. Ce progrès est actuellement bien sensible, et il y a au moins $15''$ de distance entre elles, c'est-à-dire, trois ou quatre fois plus que lorsque je fis cette observation. La petite étoile, qui est la plus au sud, a de plus beaucoup augmenté de grandeur et d'éclat..' "

A toutes ces suppositions gratuites, à toutes ces peines que M. Nicollet se donne en pure perte pour savoir si M. Méchain avait réconnu, que l'étoile ζ de la Grande Ourse étoit double, il n'y a qu'une seule réponse à faire, elle est catégorique et irrécusable, puisqu'elle est de M. Méchain lui-même.

même. C'est précisement à l'occasion de cette même étoile et sur l'observation de M. Flaugergues, que cet astronome dans une lettre écrite de Paris en 1803, à M. de Zach, et que celuici a publié dans le VIII^e^. volume de sa *Monatliche Correspondenz*, page 455, s'explique de cette manière:

" ' Ne croyez pas au mouvement du compagnon de ζ de la Grande Ourse, que M. Flaugergues a annoncé dans notre *Connaissance des Tems*, An. XI. Quant à moi, j'ai vu ces deux étoiles, il y a vingt-cinq ans, précisement telles que je les vois à present. Comme j'ai souvent observé cette étoile à Barcelone et à Mont-Jouy, *j'ai très-distinctement vu la petite étoile dans la faible lunette de mon cercle de Borda*, et lorsque j'amenais la grande étoile sur le fil horizontal, la petite me paraissait à une distance de deux epaisseurs de fil, c'est-à-dire, à peu près 12″ en déclinaison. J'ai depuis mesuré cette distance avec une excellente lunette acromatique, garni d'un bon micromètre, et je l'ai trouvé de 15″, et vous savez qu'elles n'ont pas la même ascension droite.'"

Voyez les Ephémérides de Berlin, pour l'an 1804, page 189, où M. Méchain promet de donner des détails ultérieurs sur cette étoile, ce qu'il, n'a pas fait, que je sache.

M. Nicollet dit, page 62, que l'observation de M. Flaugergues n'est pas appuyée de mesurés, et qu'il ignore s'il y en a eu de faites. M. Triesnecker, astronome de Vienne, justement frappé du mouvemens de cette étoile, annoncé par M. Flaugergues, en a entreprit avec un excellent micromètre objectif de Dollond, et en a fait le sujet d'un memoire, inseré dans les éphémérides de Vienne pour l'an 1804, page 377: " *De stella duplici, quæ est media in cauda Ursæ Majoris litera* ζ *designata.*"

M. Triesnecker ne décide pas la question, par la bonne raison que ses observations n'embrassent pas un assez long intervalle de tems: mais M. de Zach fait voir que des observations d'un demi-siècle, et même d'un siècle et demi, ne decident aucun mouvement de ces étoiles. Il démontre que les observations de Bradley dans les années 1750—1755; de Herschel en 1782—1783; de Piazzi en 1790—1798; de Struve en 1818—1819, donnaient toutes la même distance à ces deux étoiles, telle que l'avait trouvé M. Triesnecker en 1800—1801. Ce qui est remarquable, c'est que Flamsteed avait déja reconnu en 1682, avec ses mauvaises lunettes, que l'étoile ζ de la Grande Ourse était double. Dans son *Historia Cœlestis Britannica*, vol. i. p. 100, il caracterise cette étoile en ces termes: " *Clarissima* trium, *minor vel insidens ad* ζ (*Alcor*) *tertia telescopica est.*" A plus forte raison MM. Méchain et Delambre devaient voir avec les lunettes acromatiques de leurs cercles, que cette étoile était double, du moins ils devaient savoir,

voir, que Flamsteed, il y a plus d'un siècle, l'avait deja connue comme telle; d'ailleurs tous les catalogues modernes la désignent comme double.

Ce qui est plus singulier encore, c'est qu'en 1722, un Professeur des mathématiques à l'Université Giesen en Hesse, nommé Liebknecht, en régardant avec ses trsè-mauvaises lunettes l'étoile ζ de la Grande Ourse, y dêcouvrit une très-petite étoile à la quelle il avait cru avoir remarqué un mouvement. Aussitôt il en fit un nouvel astre, au quel il donna, en honneur et gloire de son souverain Louis Jean Guillaume, Landgrave de Hesse-Darmstadt, le nom de *Sidus Ludovicianum*. Liebknecht publia deux dissertations sur sa nouvelle découverte, qu'on avait d'abord révoquée en doute, ensuite contestée; cela a fini par des disputes virulentes, par des invectives grossières, par les quelles on n'a pas moins prouvé, que la prétendue découverte n'était qu'une chimère, et le nouvel astre qu'une étoile ordinaire de 8^{e} grandeur, toujours à la même place. Voyez la *Bibliographie Astronomique de Lalande*, page 377.

Voyons à present, si M. Nicollet a été plus heureux dans ses explications en supposant que l'erreur en quéstion était due à l'imperfection des déclinaisons des étoiles, observées à Mont-Jouy et à Barcelone. Mais, à quoi bon ces déclinaisons? Il ne s'agit ici que de l'amplitude de l'arc du méridien; la différence des distances au zenith de la même étoile observées aux deux extremités de cet arc, donneront directement cette amplitude sans faire intervenir les déclinaisons, ni les latitudes de deux stations. Dans toutes les mesures des degrés du méridien faites à l'Equateur, au Pôle, en Pensylvanie, au Cap, en Italie, en Autriche, en Hongrié, &c. on n'a employé que les distances au zenith observées pour déterminer l'arc céleste. Il vaudrait mieux que ces observations se fissent simultanément, comme on l'avait fait au Perou, aux deux extremités de l'arc, à Tarqui, et à Cotchesqui, mais il n'en peut résulter aucun inconvénient, si les observations de mêmes étoiles, faites sur les deux points, ont été entrepris dans un petit intervalle de tems; puisque on peut les réduire à un même instant, avec tant d'exactitude, comme si elles eussent été faites simultanément. Les observations à Mont-Jouy, ne sont séparées de celles faites à Barcelone que d'une année, ces observations ayant été faites de deux cotés dans la même saison, la différence des distances au zenith n'étant pas même une minute en arc, les élémens de réduction, tels que la réfraction, la précession, l'aberration et la nutation, ne peuvent varier d'une manière aussi sensible pour altérer ces observations. Mais, supposons qu'on eut passé par des déclinaisons et par des la-

titudes fautives, comme il ne s'agit ici que des différences, et non des quantités absolues, ces erreurs sont éliminées, et on ne conçoit pas, comment elles peuvent influer sur la détermination de l'amplitude de l'arc, à moins qu'on n'ait observé *différentes* étoiles aux deux stations, comme cela est effectivement arrivé à Mont-Jouy et à Barcelone, où l'on a observé dans le premier lieu les étoiles α du Dragon, et β du Taureau, qu'on n'a pas employé dans le second lieu; en revanche on a observé à Barcelone l'étoile α du Cocher, dont on n'a pas fait usage à Mont-Jouy, et c'est bien ce qui explique l'accord apparent et illusoire que M. Nicollet trouve entre les observations faites sur ces deux points. Mais si l'on veut s'astreindre, comme cela doit se faire, *aux mêmes étoiles*, et réduire leurs distances au zenith observées de part et d'autre, à un même instant, on trouvera un tout autre resultat, et c'est ce que nous avons fait. Nous nous sommes par conséquent uniquement attaché à l'étoile polaire, à β de la Petite Ourse, à ζ de la Grande Ourse, et à β des Gémeaux, parceque ces étoiles ont été observées aux deux extremités de l'arc, à Mont-Jouy et à Barcelone. Nous avons exclus de nôtre calcul, les étoiles α du Dragon, α du Cocher, et β du Taureau, qu' n'ont été observées qu' isolément, et d'un seul coté. Nous avons calculé avec le plus grand soin, les trois étoiles circum-polaires et β des Gémeaux, avec les données les plus récentes sur la réfraction, la variation, l'aberration, et la nutation, et nous avons réduit toutes les distances *apparentes* au zenith observées, en distances *vraies*, pour l'époque du 1 Janvier de l'an 1793 et 1794. Voici les résultats que nous avons obtenus.

Distances vraies au Zenith le 1 Janvier 1793 et 1794.

		Nombre d' Observat.
1. *Etoile polaire à son passage au méridien supérieur.*		
A Mont-Jouy 1793	46° 50′ 23″,17	176
A Barcelone 1793	46 49 21 ,98	104
Amplitude de l'arc du méridien . . .	61 ,19	280
Selon les mesures géodesiques cette amplitude est	59 ,33	
Erreur . .	— 1 ,86	
2. *Etoile polaire à son passage au méridien inférieur.*		
A Mont-Jouy 1793	50° 24′ 53″,54	140
A Barcelone 1793	50 23 54 ,10	104
Amplitude de l'arc	59 ,44	244
Selon les mesures géodesiques	59 ,33	
Erreur . .	— 0 ,11	

3. β de

3. β *de la Petite Ourse au méridien supérieur.*		Nombre d' Observat.
A Mont-Jouy 1794	33° 37′ 36″,49	144
A Barcelone 1794	33 36 33 ,84	116
Amplitude de l'arc	62 ,65	260
Selon les mesures géodésiques	59 ,33	
Erreur . .	−3 ,32	
4. β *de la Petite Ourse au méridien inférieur.*		
A Mont Jouy 1794	63° 38′ 24″,92	144
A Barcelone 1794	63 37 21 ,76	108
Amplitude de l'arc	63 ,16	252
Selon les mesures géodesiques	59 ,33	
Erreur . .	−3 ,83	
5. ζ *de la Grande Ourse au méridien supérieur.*		
A Mont-Jouy 1794	14° 38′ 05″,43	82
A Barcelone 1794	14 37 07 ,33	80
Amplitude de l'arc	58 ,10	162
Selon la mesure géodesique	59 ,33	
Erreur . .	+1 ,23	
6. ζ *de la Grande Ourse au méridien inférieur.*		
A Mont-Jouy 1794	82° 37′ 63″,50	82
A Barcelone 1794	82 36 58 ,62	80
Amplitude de l'arc	64 ,88	162
Selon la mesure géodesique	59 ,33	
Erreur . .	−5 ,55	
7. β *des Gémeaux, au midi.*		
A Mont-Jouy 1794	12° 51′ 09″,73	40
A Barcelone 1794	12 52 07 ,56	100
Amplitude de l'arc	57 ,83	140
Selon les mesures géodesiques	59 ,33	
Erreur . .	+1 50	

Le tableau ci-dessus fait voir que les anomalies de 3 à 4 secondes, qui ont donné tant d'inquiétudes à M. Méchain, n'ont été nullement éxpliquées, qu'elles subsistent toujours dans toute leur intégrité, et qu'elles vont même jusqu'à 5 secondes et demi. Ce qui merite d'être remarqué, c'est que M. Delambre dans le 2 tome de la *Base du Système Métrique*, dit, page 587: "Il est impossible de trouver des observations qui s'accordent mieux ensemble que ces différentes séries de β de la

Petite Ourse dans ses deux passages." Or, c'est là précisement l'étoile qu' a donné cette anomalie inexplicable et inexpliquée de 3 à 4 secondes. Faudra-t-il donc revenir aux soupçons de feu M. Méchain, qui ont fait les tourmens de derniers jours de sa vie, qui l'ont abreuvé d'amertumes, et qui l'ont précipité dans le tombeau?

XXIX. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from page 126.]

Genus 42. GASTROPACHA, *Ochs.**

Lasiocampa, Schrank, Latr.
Odenesis, Lasiocampa, Clisiocampa, Curtis.
Gastropacha, Eutricha, Odonestis, Lasiocampa, Pœcilocampa, Cnethocampa, Eriogaster, and Clisiocampa, Stephens.

Obs. Ochsenheimer remarks that this genus embraces, in fact, several groups well distinguished by peculiar characters, yet

* In the twenty-third Number of his Illustrations of British Entomology, published on the first of this month (February, 1829), Mr. Stephens has introduced some further divisions of certain of the preceding genera of Ochsenheimer, which we take the earliest opportunity of communicating to our readers.

1. Genus Fumea, Haworth, adopted to receive the five following species, separated from Schrank's Genus Psyche, as given by Ochsenheimer; viz. *nitidella, pulla, muscella, bombycella?* and *pectinella.*

"Fumea, Haw.

"*Palpi* and *maxillæ* wanting, their place occupied by a tuft of hairs. *Antennæ* of the male elongate, bipectinated, the pectinations subclavate, ciliated and straight; of the female very short, simple, the two basal joints largest: *head* pilose anteriorly: *thorax* slightly hairy, and generally glossy: *abdomen* of the male pilose, with a tuft at the apex; of the female more robust, with a woolly mass at the tip: *wings* incumbent, of the male diaphanous, deeply ciliated, pilose; of the female wanting: *legs* rather stout, the *posterior tibiæ* very pilose, with elongate spurs at the apex. *Larva* inclosed in a case, in which it changes to *pupa*."—*Steph. Illust. Brit. Ent. Haust.* II. p. 81.

2. Genus Nudaria, Haworth, adopted to receive the three species, *mundana, hemerobia* and *senex,* separated from the *Lithosiæ* of Fabricius, Latreille and Ochsenheimer.—Stephens's second species, *hemerobia,* Hübn. is quoted by Ochsenheimer as synonymous with *mundana.*

"Nudaria, Haw.

"*Palpi* minute, curved upwards, squamous, triarticulate, the two basal joints of equal length, the terminal minute, cylindric: *maxillæ* longer than

yet so passing into one another, that he did not think fit to divide them into separate genera. He accordingly merely marked the several groups, by the imaginary family lines, A, B, and C, without assigning other names to any of them than the general one, *Gastropacha*, which he adopted in consequence of a pretty universally prevailing

than the head. *Antennæ* simple in both sexes, ciliated beneath in the males: the basal joint robust, elongate, with a dense hairy tuft: *head* with a dense fascicle of hairs between the antennæ: *thorax* not crested: *abdomen* pilose, slender in the males, with a tuft at the apex; more robust in the females, the tip rather conical: *wings* slightly deflexed, more or less elongate, rounded posteriorly, diaphanous, pilose: *legs* rather slender, naked, the two posterior joints with spurs at the tip. *Larva* exposed, hairy: *pupa* obtuse."—*Steph. l. c.* II. p. 83.

Nudaria is distinguished "from the rest of the Arctiidæ (except *Hypercompa*) by the length of its maxillæ, which considerably exceeds that of the head."—*Steph. l. c.*

3. Genus Heterogenea, Knoch. The only species which Stephens records under this genus is *asellus*, (Hepialus asellus, Fab.)—It is not included by Ochsenheimer with his *Hepiali*, nor can I find it introduced by him, any where else.

"Heterogenea, Knoch.

"*Palpi* minute, densely clothed with scales, triarticulate, the second joint longest, the last minute: *maxillæ* wanting. *Antennæ* of the female simple, slightly pubescent at the tip, with a small tuft of hairs at the end: *head* slightly hairy: *thorax* and *abdomen* scaly: *wings* opaque, scaly: *anterior* subtriangular, acute; *posterior* suborbiculate: *legs* rather slender; *posterior tibiæ* short, robust, with rather long spurs at the apex. *Larva* ovate, without legs, naked, depressed: *pupa* folliculated. Differs from *Limacodes* by the form of the anterior wings, which are trigonate, and somewhat truncated posteriorly."—*Steph. l. c.* p. 84.

4 .Genus Limacodes, Latreille. This is the last of the Arctiidæ; and the species, *testudo*, the only one which Stephens places in it, is also a Hepialus of Fabricius, and like the last, not noticed by Ochsenheimer.

"Limacodes, Latr.

"*Palpi* short, a little ascending, densely clothed with scales and short hairs, triarticulate, basal joint short, second as long as the other two, robust, subcylindric, terminal, the length of the first, slender, subfusiform, slightly acute: *maxillæ* obsolete. *Antennæ* simple, of the male stout, compressed, rather serrated, pilose at the apex, of the female slender, a little serrated towards the apex, which is acute: *head* moderate, very hairy: *thorax* stout: *abdomen* slightly robust, a little tufted in both sexes at the apex, rather stoutest in the female: *wings* opaque, deflexed: *anterior* elongate, subtrigonate, posterior margins rounded: *legs* very stout, short; *femora* and *tibiæ* with a broad fringe of hairs; *anterior tibiæ* simple, four posterior with spurs at the apex. *Larva* very stout, naked, limaciform, gibbous above, flat beneath, apodous: *pupa* robust, obtuse, posteriorly acute; inclosed in a dense ovate folliculus.—Limacodes differs from Heterogenea at first sight by the stoutness of its thorax and abdomen, the elongation and rotundity of its anterior wings, and the robustness of its antennæ; the proportions and comparative bulk of the palpi, and other less evident characters."—*Steph. l. c.* p. 85.

5. Genus

vailing character; viz. the remarkable thickness of the abdomen of the female moth, deriving the term from the two Greek words γαστηρ *venter*, and παχυς *crassus*. That other authors have not thought with Ochsenheimer, as to the propriety of creating new genera and new names, is pretty evident, from the list of synonyms immediately preceding these observations; and in the present instance they seem to be right.

Fam. A. — *Antennæ* bipectinate; *palpi* porrected; *wings* dentated; *anterior* deflexed; *posterior* projecting beyond the *anterior* when at rest; *haustellum*, none: *larva* flat beneath, convex above, semirugose; second and third segments with one or two transverse bands, and a conical tubercle on the penultimate, and similar shaped, tufted tubercles on the sides: *metamorphosis* above ground, in a rather long web covered on the inside with a whitish powder.

	Species.	Icon.
1.	G. *Ilicifolia*, Linn.*	Ernst, IV. Pl. CLXVIII. f. 219. a. b.
2.	— *Betulifolia*, Ochs.	Ernst, IV. Pl. CLXVIII. f. 220. a—k.
3.	— *Populifolia*, Fab.	Ernst, IV. Pl. CLXVII. f. 218. a—g.
4.	— *Quercifolia*, Linn.*	Ernst, IV. Pl. CLXVI. f. 217. a—g. Curtis, I. Pl. 24. Imago et larva.

5. G. *Alni-*

5. Genus Callimorpha, Latreille. This genus and Lithosia, Latr. form each a part of Ochsenheimer's genera Lithosia, and Eyprepia. Mr. Stephens places Callimorpha at the head of his first family of the nocturnal Lepidoptera, the Lithosiidæ[a], and arranges under it the two British species *Jacobææ* and *Miniata:* (Lithosia, *Jacobææ*, and *Rosea*, Ochs.)

" Callimorpha, Latr.

" *Palpi* short, a little descending or horizontally porrected, slightly hairy, triarticulate, the basal joint elongate-ovate, as long as the two following, which are of equal length, and subovate or attenuated, with the terminal one acute: *maxillæ* longer than the head. *Antennæ* setaceous, slightly ciliated in the males: *head* small, rather hairy in front: *thorax* and *abdomen* clothed with silken scales; the latter somewhat robust in the female, slightly tufted in the male: *wings* rather broad, anterior elongate-trigonate, with the hinder margin rounded or subelliptic: *legs* moderate; *tibiæ* short, the posterior with two pair of spurs. *Larvæ* sparingly covered with hairs, or densely pilose, the head nearly naked: *pupa* obtuse or acute."—*Steph. Illust. Brit. Ent. Haust.* II. 89.

* Gastropacha, Steph.

" *Palpi* elongate, porrected, hairy, triarticulate, the second joint longest; the

[a] Consisting of the genera *Callimorpha*, *Eulepia*, *Deiopeia*, *Lithosia*, *Gnophia*, and *Setina*, as stated in the tabular view of the family, p. 89.

Species.	Icon.
5. G. *Alnifolia*, Ochs.*	— — —
6. — *Pini*, Linn.†.....	Ernst, IV. Pl. CLXX. f. 222. a—h. Pl. CLXXI. f. 222. i—o.
7. — *Pruni*, Linn.....	Ernst, IV. Pl. CLXIX. f. 221. a—g.

Fam. B. The two following species are placed in this division, as connecting the first and third families, *Gastr. potatoria* being nearly allied in its characters to the species of the family A. and G. *lobulina* to those of family C. Ochsenheimer gives no separate characters for this division.

the terminal obtuse: *maxillæ* very small. *Antennæ* short, recurved, strongly bipectinated in both sexes: *head* small, with an acute, projecting hairy tuft: *thorax* and *abdomen* robust, densely pilose, the latter acute in the female: *wings* dentated, reversed during repose: *legs* moderately stout: the *femora* and *tibiæ* pilose. *Larva* broad, rounded above, with fascicles of hair on the sides, each segment with a fleshy lateral appendage, and on the penultimate joint a distinct truncated tubercle: *pupa* obtuse, inclosed in an oblong, broadly constructed cocoon and covered with a whitish powder." — *Steph. Illust. Brit. Ent. Haust.* II. p. 52.

* Gastr. alis reversis, subdentatis, cuprinis, strigis undatis, nigris.— (*Ochs.* IV. p. 205.)

† Odonesis, Curtis; Eutricha, Hübn. Steph.

" *Palpi* not very long, porrected, triarticulate, two basal joints of equal length, terminal more slender and obtuse: *maxillæ* short, a little spiral. *Antennæ* nearly straight, not very short, deeply bipectinated in the males to the apex, which is a little bent; slightly bipectinated in the females: *head* small; *thorax* robust, densely pilose: *abdomen* the same, rather elongate; more robust in the females: *wings*, *anterior* entire, rounded posteriorly; *posterior* obsoletely denticulated, reversed during repose: *legs* rather slender, not very pilose, with minute spurs at the apex of the tibiæ. *Larva* cylindrical, with fascicles of hairs down the sides, and a tubercular eminence on the penultimate joint: *pupa* short, obtuse, inclosed in an elongate, subfusiform, loosely-constructed cocoon."—*Steph. Illust. Brit. Entom. Haust.* II. p. 50.

Curtis's generic characters agree, of course, almost exactly with Stephens's, except as regards the middle joint of the palpi, " twice the length of either of the others," which is one of the principal characters assigned by Stephens as a reason for separating *Bo. Pini*, Linn., from Odonestis, the type of which genus, both according to Curtis and Stephens, is *Bo. potatoria*, Linn. Curtis also doubts the existence of maxillæ and mandibles. His description is accompanied, as usual, with a beautiful plate (vol. i. Pl. 7.) on which is represented the figure of a male perfect insect, taken at Norwich, and that of the female caterpillar, copied from Roësel, together with figures of the dissected antennæ and palpi, magnified.

8. G. *Pota-*

Species.	Icon.
8. G. *Potatoria*, Linn.*	Ernst, V. Pl. CLXXII. f. 223. a—h.
9. — *Lobulina*, Fab. ...	Hübn. Bomb. Tab. 41. f. 186. (mas.) 181. (fœm.)

Fam. C. *Antennæ* bipectinate, in the male, very strongly, more slightly in the female: *haustellum* very small: *wings* entire, deflexed; the *anterior* with one or two transverse bands, and generally a white spot near the middle of the disc. *Larva* covered with short hairs, resembling pelt; when touched it rolls itself up: *metamorphosis;* the *first* species changes in a rigid cylindrical cocoon; the last in a soft, rather elongated web.

10. G. *Trifolii*, Hübn. †.	Ernst, V. Pl. CLXXVI. f. 226. a. b. e.
11. — *Medicaginis*, Borkh.†	Ernst, V. Pl. CLXXVI. f. 226. c. d. f. g. i. Curtis, Brit. Ent. IV. pl. 181. Imago et larva.

12. G. *Quercus*,

* Odonesis, Curtis.—Odonestis, Germar. Steph.

" *Palpi* elongate, porrected, hairy, triarticulate, the basal joint not half as long as the second, the terminal rather larger than the basal, obtuse: *maxillæ* obsolete. *Antennæ* slightly curved near the base, bipectinated, especially in the males, to the apex: *head* small: *thorax* stout, loosely, but thickly pilose; *abdomen* the same, elongated, and tufted at the apex in the males, somewhat acute and stout in the females: *wings* reversed when at rest; *anterior* rather acute at the tip, the posterior margin rounded, entire; *posterior* slightly denticulate: *legs* stout, densely pilose, especially in the males, with spurs at the apex of the tibiæ. *Larva* robust, cylindric, with fascicles of hair down the sides, a distinct tuft on the neck, and another placed on a minute tubercle on the penultimate joint: when alarmed it rolls itself in a ring: *pupa* robust; obtuse, placed in a fusiform, closely woven, luteous cocoon." —*Steph. Illust. Brit. Ent. Haust.* II. p. 51.

† Lasiocampa, Schrank, Curtis, Stephens, Leach.

" *Antennæ* inserted towards the hind part of the head, nearly straight, setaceous, strongly bipectinated in the males, each branch being ciliated and producing a rigid bristle near the apex, inclining upwards: serrated in the females: *maxillæ* and *mandibles* none.

" *Palpi* 2, small, short, hairy; 3-jointed, 1st and 2nd joints robust; the former the longest; 3rd minute, ovate. *Males* smaller than the females.

" *Head* short. *Eyes* small. *Thorax* large, not crested. *Abdomen* of the males attenuated and divided at the apex; robust and subovate in the females. *Wings* entire, deflexed when at rest. *Tarsi* 5-jointed. *Claws* and *pulvilli* distinct.

" *Caterpillars*

Species.	Icon.
12. G. *Quercus*, Linn.*...	Ernst, V. Pl. CLXXIV. f. 225. a—f.
13. — *Rubi*, Linn.*.....	Ernst, V. Pl. CLXXIII. f. 224. a—i.

Fam. D. *Antennæ* bipectinated, pectinations in the male very broad: *wings* not densely covered with scales; *abdomen* pilose, with black and yellow bands. *Larva* slightly hairy, with two rows of black spots on the back: do not roll themselves up when disturbed: *metamorphosis*, subterranean, without any web.

14. G. *Taraxici*, Fab....	Hübn. Bomb. Tab. 37. f. 165. (mas.) 166. (fœm.)
15. — *Dumeti*, Linn.† ...	Ernst, V. Pl. CLXXVII. f. 227. a—g.

Fam. E. *Antennæ* curved, finely pectinated in the male, scarcely perceptibly so in the female: *wings* deflexed, the *anterior* generally with two transverse bands, and occasionally a small, bright spot. *Abdomen* hairy; generally terminated, in the female by a dense tuft of soft hairs, with which she covers her eggs. *Haustellum* none. *Larva* elongated, slightly hairy, gregarious when young: *metamorphosis*, above ground in an oval cocoon.

Obs. Ochsenheimer, on Hübner's authority, subdivides this family into three sections, but gives no distinctive cha-

"*Caterpillars* with 6 pectoral, 8 abdominal, and 2 anal feet; cylindrical and hairy, curling themselves up when disturbed.

"*Pupæ* inclosed in an obtuse, oblong cocoon of very close texture."—*Curtis, Brit. Ent.* IV. p. 181.

Curtis assigns the following characters as distinctive of the three genera Gastropacha, Odonestis, and Lasiocampa; including the two former in one section, the last in another.

A. *Palpi* long. Inferior wings when at rest projecting beyond the costa of the superior. *Larvæ* not cylindric, having fascicles of hair down the sides, and a dorsal tubercle near the apex. *Cocoons* long, attenuated, silky and soft.

a. *Antennæ* curved. *Tongue* short. *Wings* denticulated.

Gastropacha.

b. *Antennæ* straight. *Tongue* none. *Wings* not denticulated.

Odonestis.

B. *Palpi* minute. Inferior wings not projecting when at rest. *Larvæ* cylindric, clothed with hairs. *Cocoons* oblong, obtuse, dense and rigid in texture,

Lasiocampa.

* Lasiocampa, Curtis, &c. † Lasiocampa, Steph.

racters for either, which, he says, are better obtained by description of the separate species respectively, than they can be collectively, from the groups.

Species.	Icon.
16. G. *Populi*, Linn.*....	Ernst, V. Pl. CLXXXIII. f. 236. a—g.
17. — *Cratægi*, Linn.†..	Ernst, V. Pl. CLXXXII. f. 235. a—e.
18. — *Processionea*, Linn.†‡	Ernst, V. Pl. CLXXXIV. f. 238. a—f.
19. — *Pityocampa*, Fab.‡	Ernst, V. Pl. CLXXXIV. f. 239. a—f.
20. — *Catax*, Linn.....	Ernst, V. Pl. CLXXVIII. f. 229. a—e.

* Pœcilocampa, Steph.[a]

"*Palpi* extremely minute, subglobose, enveloped in slender elongate hairs: *maxillæ* obsolete. *Antennæ* densely bipectinated in the males, the pectinations scarcely decreasing towards the apex; strongly serrated in the females: *head* very small, and hairy: *thorax* stout and hairy: *abdomen* abbreviated, tufted in the male, and pilose laterally in both sexes, the female without a downy mass at the apex: *wings* entire, elongate, acute, subdiaphanous, not reversed during repose: *legs* with the *femora* and *tibiæ* pilose. *Larva* slightly hairy, a little depressed, maculated, not gregarious: *pupa* short, obtuse, inclosed in a silken folliculus, superficially subterranean."—*Steph. Illust. Brit. Ent. Haust.* II. 43.

† Clisiocampa, Curtis.—See Gen. Char., Species 25. *G. castrensis;* note.

‡ Cnethocampa[b], Steph.

"*Palpi* very short, enveloped in longish hairs, triarticulate, the basal joint longer, and stouter than the second, terminal minute, slender, rather acute: *maxillæ* obsolete. *Antennæ* short, slightly curved, bipectinated in the males, serrated in the females, the pectinations gradually decreasing in length to the apex: *head* distinctly visible from above: *thorax* stout, hairy: *abdomen* rather elongate, tufted, the apex of the female with a woolly mass: *wings* slightly reversed, obscurely diaphanous: *cilia* not abbreviated: *legs* slender: *femora* and *tibiæ* pilose. *Larva* gregarious, cylindrical, hairy: *pupa* also gregarious, obtuse, bidentate posteriorly, inclosed in a rigid cocoon."—*Steph. Illust. Brit. Ent. Haustel.* II. 46.

From Pœcilocampa and Eriogaster (a genus to be presently noticed); Cnethocampa differs by the tenuity and shortness of the antennæ and their pectinations in the males, and by the downy tuft at the apex of the abdomen, in the females; and from the latter genus both sexes differ by the elongation of the cilia, exclusively of differences in the trophi, &c. "The habits of the larvæ are also remarkably dissimilar to those of the above genera; and their hairs, when applied to any part of the body, cause very great irritation and acute pain, especially those of Cn. Pityocampa."—*Steph. l. c.*

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[a] Ποικιλος *varius*; καμπη *eruca.*

[b] Κνηθω *pruritum moveo*, καμπη *eruca.*

21. G. *Everia*,

Species.	Icon.
21. G. *Everia*, Fab.	Ernst, V. Pl. CLXXIX. f. 231. a—i.
22. — *Lanestris*, Linn.*	Ernst, V. Pl. CLXXVIII. f. 230. a—f.
23. — *Loti*, Ochs.	Hübn. Bomb. Tab. 60. f. 256. (mas.) 257. (fœm.)
24. — *Franconica*, Fab.	Ernst, V. Pl. CLXXXII. f. 234. a—c.
25. — *Castrensis*, Linn.†	Ernst, V. Pl. CLXXXI. f. 233. a—l. Pl. CLXXXII. f. 233. m, n. Curtis, Brit. Ent. V. Pl. 229. mas. fœm. et larva.
26. — *Neustria*, Linn.†...	Ernst, V. Pl. CLXXX. f. 232. a—n.

* Eriogaster, Germar, Steph.

" *Palpi* short, distinctly triarticulate, the basal joint longest and stoutest, the terminal minute, ovate, subacute; *maxillæ* obsolete. *Antennæ* bipectinated in the males, the pectinations decreasing in length to the apex, slightly serrated in the females: *head* small, pilose: *thorax* very stout, pilose above and below: *abdomen* robust and elongate in the females; moderate, and rather abbreviated in the males; densely clothed in both sexes with short down, and the apex in the female with a large woolly mass: *wings* elongate, entire, subdiaphanous, slightly reversed during repose: *cilia* short: *legs* short, femora and tibiæ densely clothed with wool. *Larva* gregarious cylindric, pilose, semi-annulated: *pupa* short, obtuse, not dentated at the apex, inclosed in a rigid, ovate cocoon."—*Steph. Illust. Brit. Ent. Haustel.* II. 44.

† Clisiocampa, Curtis, Steph.

" *Antennæ* inserted close to the eyes on the crown of the head, short, setaceous, bipectinated, the pectinations ciliated, long in the male, and gradually decreasing in length to the apex, short in the female. *Maxillæ* and *mandibles* none. *Labial palpi* short, and very indistinct, being concealed by scales, the basal joint producing a fascicle of hairs beneath; triarticulate; 1st joint rather robust; 2nd larger, elongate-ovate; 3rd minute oval. *Males smaller than the females.* Head *very small and scarcely visible from above.* Eyes *globose.* Thorax *very robust.* Abdomen *short and small in the male, long robust and conical in the female.* Wings *deflexed when at rest, short in the males.* Tibiæ *anterior producing a broad compressed and pubescent lobe on the inside.* Tarsi 5-*jointed, basal joint the longest.* Claws *simple.* Pulvilli *distinct.* Caterpillars *with* 6 *pectoral,* 8 *abdominal, and* 2 *anal feet, cylindrical and hairy.* Pupæ inclosed in a long silky cocoon."—*Curtis, Brit. Ent.* V. Pl. 229.

[To be continued.]

XXX. *Table of the Arrival of some of the Summer Birds of Passage in the Neighbourhood of Carlisle, during the Years* 1827 *and* 1828; *with Observations, &c. By* A CORRESPONDENT.

No.	English Specific Names.	Latin Specific Names.	Year 1827.	Year 1828.
1	Swallow	Hirundo rustica	April 20	April 18
2	Martin	——— urbica	22	28
3	Sand Martin	——— riparia	6	4
4	Swift	Cypselus apus	29	29
5	Goatsucker	Caprimulgus europæus	30	May 3
6	Pied Flycatcher	Muscicapa atricapilla	14	April 27
7	Spotted Flycatcher ..	——— grisola ..	May 17	May 14
8	Wheat-Ear	Saxicola œnanthe ..	April 29	April 19
9	Whinchat	——— rubetra	30	27
10	Redstart, male.....	Sylvia phœnicurus..	8	17
	——— female ...	.....	28	27
11	Grasshopper Warbler	Curruca locustella ..		May 1
12	Sedge Warbler.....	——— salicaria ..	29	April 28
13	Greater Pettychaps ..	——— hortensis ..	May 8	May 8
14	Wood Wren	——— sibellatria..	April 29	April 29
15	Blackcap, male	——— atricapilla .	27	24
	——— female	.....	28	
16	White-Throat	——— sylvia	29	27
17	Yellow Wren	Regulus trochilus ...	15	14
18	Yellow Wagtail	Motacilla flava	9	14
19	Field Lark or Titling	Anthus trivialis		29
20	Cuckoo	Cuculus canorus....	28	23
21	Wryneck	Yunx torquilla	18	17
22	Corncrake	Ortygometra ana ..	May 5	April 20

Pied Flycatcher.—I have no doubt the Pied Flycatcher arrived this year (1828) much sooner than is stated above; but the situation it resorts to being at some distance, I had not an opportunity of visiting the locality before the 27th of April, on which day I saw several pairs. I am fully aware that this species is considered by many British naturalists to be indigenous to this country, and consequently ought not to be considered as a bird of passage. Amongst others, Montague is of this opinion, and has written at some length on the subject in the Supplement to his Ornithological Dictionary. On the other hand, Mr. Selby in his Illustrations of British Ornithology, considers it to be only an occasional visitant. From what has lately passed under my own observation, I am at present inclined to think that it is a regular summer visitant in this neighbourhood. In the summer of 1827 I had one and this year I have had several nests of this bird under my inspection, and hope to be able at no distant period to offer some further remarks upon the subject, which certainly requires investigation.

* Communicated by the Author.

Wheat-

Wheat-Ear.—In the immediate neighbourhood of Carlisle I have never been able to see above one or two Wheat-Ears; but I believe this bird arrives much sooner on the coast, where I have seen it in considerable numbers.

Redstart.—The Redstart made its appearance unusually early in the year 1827; as it very seldom arrives before the 18th or 20th of April.

Lesser Pettychaps (Regulus hippolais).—Although I have never yet been able to meet with the Lesser Pettychaps in this neighbourhood, I think it extremely probable that it visits some parts of this county. It has been detected by Mr. Selby in Northumberland, and also in Westmoreland, where it has been seen so early as the 26th of March, as will appear from the following table, which I have extracted from an article "On the Summer Birds of Passage, and on Migration in general, by Mr. John Gough," inserted in the 35th vol. of the Philosophical Journal.

Birds.	Migrate.		
	North.	South.	
Anas Cygnus	. . . . .	Jan. or Feb.	In hard frosts.
Fringilla montium . .	March 1	Oct. 4	
Anas Anser	8	Sept. 10	
Numenius arquata . .	10	9	
Tringa Vanellus . . .	13		
Motacilla flava	21	Oct. 24	
Sylvia hippolais	26		
Motacilla Boarula . .	April 4		
Scolopax rusticola . .	8	14	
Hirundo riparia . . .	12		
Turdus pilaris	14	18	
Sylvia phœnicurus . .	14 in exposed situations.	3	
Sylvia trochilus	April 15		
Hirundo rustica . . .	17	Sept. 25	
Tringa hypoleucos . .	22		
Sylvia sylviella	26		
Cuculus canorus . . .	27		
Hirundo urbica . . .	29		
Sylvia rubicola	May 1		
CharadriusMorinellus	2	. . . . .	A.D.1793.
Sylvia cinerea	2		
Hirundo Apus	3	Aug. 18	
Sylvia sylvicola	13		
—— hortensis . . .	15		
—— salicaria	17		

Wagtail.

Wagtail. — The other two species of Wagtail, namely *M. alba* and *M. Boarula*, are both indigenous here; many of the former, and a few of the latter, remaining the whole year.

Dr. Heysham in his Catalogue of Cumberland Animals, published in the year 1796, states that both these species entirely left this county in the winter; although he appears to have had some doubts with respect to *M. Boarula*, from the following observation: "Appears in Cumberland in the spring, and leaves it in October or November; and in very mild winters, a few, I believe, remain with us the whole year. I saw two on the 5th of January this year between the bridges." For some years past I have paid considerable attention to the subject, and I am satisfied that some of both remain here even during our most severe winters. In confirmation of which, I have observed both on the several days mentioned below, and have added to each the minimum height of the thermometer.

1824.	December	5...16°	1826.	November	27...22°
		23...24½		December	27...27
1825.	January	6...25	1827.	January	4...13
		23...25			27...16
	February	5...20		February	20...16½
	November	12...20		November	24...20¾
1826.	January	10...15		December	29...22½
		14...11	1828.	January	11...14

In concluding these desultory observations, it may not be amiss to state that the generic and specific names made use of above, are those adopted by Dr. Fleming in his recent History of British Animals, which contains one of the best and most natural arrangement of British birds hitherto published.

XXXI. *On the Laws of Mortality, and the Intensity of Human Life.* *By Mr.* Francis Corbaux.*

THE natural law according to which the waste of human life takes place, is the principal regulator of innumerable transactions. Researches of scientific men, long before this subject of consideration had acquired its present and daily growing importance, were directed to ascertain the reality of such a law, as expressing with some degree of accuracy the comparative rates of mortality at the successive stages of our lives. Actual experience—the only guide in those researches—was resorted to, but without discrimination, the necessity of which was at first overlooked. Hence the erroneous and almost unrestricted supposition, that a law of mortality inferred

* Communicated by the Author.

from

from observations made in a particular country or even limited district; and confined to an abridged period of time, might be applicable to all species of concerns depending on the probable duration of specific lives. To admit, as universal, any law of mortality whatsoever, under the present constitution of society, would be an error no less palpable. On the other hand, a very extraordinary notion, that the law of mortality had undergone a material alteration within a century, seems to have gained credit with many, who fail to reflect on the immutable character of all the laws of nature without exception. Let us endeavour to place these matters in their true point of view.

Our object is to establish, that no law of mortality can be considered absolute, nor otherwise than as a particular modification of some primary law of nature, in all probability undiscoverable;—that any stated law of mortality must be exclusively referable to a specific sex, and to a class of people precisely defined, according to certain general conditions under which all comprised in that class are understood to exist;—that a well-constructed law should, amongst other characteristics, exhibit in regular gradation the mathematical expressions of the intensity of life, for each year of age, so as to harmonize with physiological observations in that respect;—and lastly, inasmuch as such intensity materially differs in the two sexes, as also variously at different years of age,—that the progressive increase or decrease of such comparative life-intensity, relative to similar ages, ought to be distinctly expressed in the law referable to the one and in the law referable to the other sex, both belonging to the same class of selection. It is only when the law is constructed on those strict principles, that it can be truly applicable, without danger of gross miscalculation.

Doubtless, the human species, in this respect like all other species of animals, when existing under the conditions best appropriated to, and most congenial with, their respective natures, are each of them subject to a primary law by which the waste of life amongst them is governed; and it is as little to be doubted that this primary law, if it could be ascended to, would exhibit the most favourable specimen possible of human life. Even under those conditions, such a law would still be liable to many modifications, depending on accident and other circumstances; the same with the brute creation, in its immense varieties, and amongst which those which are domesticated, or others most exposed to hostile enterprise, become subject to rates of mortality far different from their original determination. But a multitude of further modifications of the primary law, relative to mankind, have been introduced consequently

to

to civilization, with its attendant inequality in the distribution of social advantages and disadvantages, and to the different circumstances of climate, soil, government, mode of living, moral and temperate habits or the contrary; as also to the greater or less liability to disease and to other causes endangering life, or tending to abridge it. Hence it becomes an indispensable requisite, that any stated law of mortality should be referable to some definite class of individuals, existing under circumstances nearly common to them all. And when it is considered that the laws hitherto published, as founded upon particular sets of local observations, made at certain limited periods, differ widely from each other in all their results and deductions,—it must follow that the indiscriminate application of any specific law, to other classes of lives than the one to which it is exclusively referable, cannot fail to generate miscalculations of the utmost consequence regarding the value of contingent property, contradistinguished from that which bears the character of certainty.

It is not merely that two classes of persons, without distinction of sex, may exist under circumstances materially different as affecting the rates of their mortality; differences of the same tendency may be no less considerable between the two sexes, though they existed under circumstances as nearly alike as could possibly be supposed. It has therefore been another error, to have admitted the application of any law of mortality to both sexes indiscriminately.

The whole course of a life, male or female, is divisible into successive periods, more or less protracted; and during each of which, the conditions of existence are maintained, with very little variation, for either sex singly considered. But those conditions necessarily undergo, in some important respects, a notable alteration, modifying not only the rates of mortality from one period to another, but also the progressive decrease of the intensity of life; nor do those periods, or natural divisions of any life, coincide as to both sexes. This consideration, more particularly belonging to the department of physiology, ought always to be kept in view when any law of mortality is constructing; but the custom has hitherto been completely to discard it. Notwithstanding the palpable absurdity of supposing, either that the waste of life, from birth to old age, was governed by any uniform law; or that males and females, whose physical constitutions and whose vocations are widely different, were subject to exactly the same rates of mortality during similar periods of their respective ages; admissions such as these have been practically proceeded upon, and pertinaciously adhered to. It would only be fastidious to enter here into

into a detail of the enormous miscalculations which have thence arisen*.

With reference to each year of age, either the fraction which measures the probability that life will endure another year, or else the corresponding quantity of living persons, out of which *one* death (precisely) is to occur during the same interval, will constitute two modes equally eligible of expressing the intensity of life from year to year. In both sexes, this intensity is less at the birth than at any intermediate period from that time, until an advanced age attainable only for the privileged few; but it gradually increases, so long as the human frame acquires any further development, and whilst nature may continue its supply of additional vigour, provided that no counteracting causes enter into operation; and from the period at which such intensity has arrived at a maximum, it invariably decreases, but in modified progressions, until all probability of life's continuance becomes extinct, as far as considered in each individual. At the same time this constant decrease has its period of limitation, with reference to any considerable number of lives of the same class, and taken together; which occurs in the following manner:—

At a certain age, which may vary from the eighty-third to the ninetieth year, according to the description of a whole population or any select portion of it, an anomaly is exhibited in the shape of apparent increase, as to the intensity of life, during a few years. Not that individual lives have actually improved; but considered in the aggregate, such as were originally constituted for outliving their cotemporaries, and who continued to exist under the most favourable circumstances, ultimately stand prominent, competing amongst themselves for protracted longevity, to the exclusion of all the rest. Indeed, this natural selection of particular lives, out of a very considerable mass, repeatedly occurs among centenaries, at later periods, and according to their respective degrees of constitutional vigour; so that very little difference may appear in the probabilities of living one more year, between two individuals of whom the ages differed even to the extent of twenty years. By duly attending to this consideration, a law of mortality may be so constructed as to represent, with all possible accuracy, the progressive expenditure of human life to the utmost attainable age, and without such statement being ever at variance with recorded facts of longevity, however extraordinary.

* After analysing all the laws of mortality set forth to the present time, critical remarks upon them, and other matter connected with this subject, have been given in the "Atlas," of the 6th, 20th, and 27th of April, 4th and 20th of May, 1828.

When the development is complete, and all additional supply of vigour has ceased, the ordinary exercise of life, even without abuse, sufficiently accounts for the constant diminution of its intensity. Life, disengaged from the trammels of infancy, has its period of restlessness, toil and danger; but during which, nature is proportionately bountiful in other respects. It next has a period characterized by comparative calmness of the human passions, but its usual attendants are the development of diseases which were only incipient, together with an increased liability to other diseases; and this is superseded by another period, of nearly absolute repose, in which the character of prevailing diseases has changed, and which is not incompatible with vigorous health. From the different circumstances attendant on those periods, and on their respective subdivisions, the ratio of progressive diminution in the intensity of life is also different during each of them; sometimes proceeding by increment, and at other times by decrement, according to the ascertainable operation of combined causes.

To whatever class of selection any law of mortality may refer, the intensity of a female is always superior to that of a male life of similar age, until the anomalous period last mentioned; but from the characteristic difference already noticed, in the respective conditions of their existence, this superiority is not the same for every year of age. It is more considerable at the birth than at any future period; as evinced by the proportion of about *seven* deaths occurring amongst females, to *eight* occurring amongst males, during their first year, out of any equal number of births of each sex and belonging to a select class. This proportion of advantage, attributable to females, rapidly decreases to the sixth or seventh year, more or less, and according to the specific class; it then ascends, in regular progression, until it attains a maximum at twenty-seven years of age, or thereabouts; after which a progressive decrease again takes place, terminating with the forty-first year, when, with reference also to a select class of lives, the respective intensities are nearly on a level for both sexes. From the latter period, the same superiority is manifested in a constantly increasing progression to the seventy-fourth year, when only it commences to decline; and about the eighty-fourth, it ultimately yields the advantage to male lives.

If the comparative intensity of life, in both sexes, be not considered relatively to specific and successive ages, but in a more absolute sense, as measurable by the respective averages of forthcoming years at the birth, and usually, though improperly,

perly, termed *expectation of life**; it will then appear, that the superior intensity of female lives is in a more considerable proportion amongst the inferior classes, than amongst those selected as existing under a series of circumstances generally favourable to the preservation of life at all its stages. This difference, in the aggregate, will also be conspicuous in the detail, though with some variation in the progressive ratios, and likewise in the respective periods of increase and decrease.

Any two laws of mortality, the one applicable to male and the other to female lives, both of the same class of selection, will, unless defective, present all those differences in their proper light.

With reference to either sex, a very considerable difference takes place in the maximum of intensity, as also in the year of age at which it occurs, between lives of a superior and those of an inferior class. In the instance of lives belonging to a select class, to which the *annuitants* may generally be assimilated, the maximum of intensity for females, and expressed by a required quantity of the living for producing *one* death before the expiration of another year, is 270, and referable to fifteen completed years of age; whilst it is 236 only for males, and referable to the age of fourteen years: and for the inferior class of either sex, involving the great mass of people who exist under circumstances of hardship and privation, the maximum thus expressed scarcely exceeds a hundred, referable to an earlier age even than that of *ten* years†; after which the intensity of life, for this class, begins to decrease. Facts of this description abundantly testify how inapplicable the law of mortality must be to any other class than the one to which it expressly refers.

A principal feature, indicative of the quality of lives to which any such law may be referable, is the comparative number of population, whether general or select, and of the specified sex, that should permanently result from any given quantity of annual births, compensating an equal quantity of deaths understood to occur during the same interval. This fiction, of an absolutely stationary population, is requisite for enabling the stated law of mortality to fulfill at once *two* indications: first, the progressive decrement, from year to year, of indivi-

* The *true expectation* is the period of years at the expiration of which the living, at any stated age, will be reduced to *half* their number; thereby indicating an equal probability of outliving that period or not.

† These remarks are not stated with greater precision, because the law applicable to the inferior class alluded to (being the *fifth* and last) is not yet completed.

duals remaining alive, out of the quantity supposed annually to be born; and secondly, the absolute quantity of the living, at each year of age: which quantities constitute the distribution of the whole comparative population just mentioned.

Whilst the greater superiority of the selected class necessarily produces the greater sum of permanent population, as arising from any common radix of annual births, that relative sum, also regulating the average of forthcoming years that belong to each infant born, differs less, as regards the contradistinguished sexes, than it does in case of lives of an inferior quality. If $2\frac{3}{4}$ years' difference in that average takes place from one sex to the other, respecting a class selected as *perfect*, that quantity will extend to 3 years for a second class to which the *life-annuitants* may be assimilated; to $3\frac{1}{4}$ for a third class, or that of *assurable lives*; to $3\frac{1}{2}$ for the *general population* of such countries as Great Britain or France, and even to *four* years for the inferior qualities of lives amongst that general population.

The superior intensity, thus measured, of one class of lives over another, without regard to difference of sex, is mostly derived from the circumstances that attend early stages of life. When, on the contrary, infancy is subject to unfavourable conditions of existence, no consideration of comparative healthiness at subsequent ages, or of remarkable longevity amongst the survivors, could afford any adequate compensation for the curtailment resulting, in the population, from a deficiency of wholesome subsistence, or of proper care towards the maintenance of health, during infancy. In one country or district, where those advantages are fully enjoyed, though from other circumstances the rates of mortality should become very elevated after the meridian of life is passed, the comparative population growing out of an equal quantity of annual births, may be as *three* to *two*, with that of another country or district in which infancy suffered privation and neglect; though from advantageous circumstances of climate and soil in the latter, the mortality proceeded at a very slow pace amongst the survivors, and the observation of facts tended to establish there at very high rates the expectation of life in old age. This again gives warning of the caution with which data, merely local or circumstantial, ought to be admitted, and of the errors likely to follow an extended application of them.

Nevertheless, the data now possessed towards constructing a law of mortality applicable to either sex and of any specific class, are sufficient for obtaining very satisfactory results; provided they are judiciously employed, and that their comparison be governed by an attentive consideration of physiological principles.

principles. The problem then to be solved, is that of distributing with all possible accuracy, according to those principles, and relatively to the circumstances under which any population or select class is acknowledged to exist, the comparative total of such population (supposed stationary) or class as arising from a stated quantity of annual births.

5, Hercules' Buildings, Lambeth. 7th Nov. 1828.

XXXII. *Some Arguments tending to prove that the Earth is a Solid of Revolution. By* James Ivory, *Esq. M.A. F.R.S. &c.**

IN the investigation of the figure of the earth, the first point that engages attention, is to determine the nature of the meridians. Are these all equal and similar curves? or are they variable or irregular in their form? It can hardly be expected that these questions can be answered with the strictest mathematical precision. There will occur, it is likely, discrepancies caused both by local circumstances and by the want of perfect exactness in the data of observation. But at the same time that, in every particular measurement, the greatest care must be taken to insure the utmost degree of accuracy compatible with experimental operations, we must likewise endeavour to deduce some general conclusion from a comparison of the whole series of individual results, and to form a general notion of the figure of the earth, overlooking local and casual irregularities. Unless we thus attempt to generalize the knowledge we obtain, the inquiry, it is evident, would lose much of its interest and utility. The most probable inference that we can at present draw from the best measurements that have been made, is that the meridians are equal and similar ellipses, the difference of the two semi-axes being about ·00324 of the equatorial semi-diameter.

But if the meridians be equal and similar ellipses, the earth must necessarily be an oblate spheroid of revolution. And there are not wanting arguments that very forcibly confirm this inference. In all times, past and present, it has been assumed that a terrestrial meridian is a plane containing the earth's axis; and likewise that a plumb-line, or a perpendicular to the earth's surface, lies wholly in one plane with the same axis. All astronomy is built on these suppositions, and no grounds have ever occurred that make their accuracy questionable. Now the properties we have mentioned belong ex-

* Communicated by the Author.

clusively

clusively to solids of revolution; and therefore such, it would seem, must be the figure of the earth, either exactly, or so nearly that the difference is insensible to our observations.

If, according to the foregoing reasoning, we assume that the earth is a spheroid of revolution, and that the dimensions of the meridians are known, we are in a condition to calculate every circumstance relating to a line measured upon its surface, provided we have ascertained the position of the extremities of that line. From actual measurements made either exactly perpendicular to the meridian, or nearly so, we can deduce the length of a perpendicular degree at a certain latitude on the given spheroid; and if it be found that the result thus obtained accords with the length of the same degree derived solely from the dimensions of the meridians, there is a presumption at least in favour of the assumed figure of the earth. It was in this point of view that, in some former Numbers of this Journal, I examined some of the most remarkable measurements perpendicular to the meridian. The computations that were made, prove at least that the same compression which represents very accurately the lengths of the meridional arcs, agrees equally well with the perpendicular measurements. It would, no doubt, have been very desirable and more satisfactory, if we had had it in our power to compare the computed difference of longitude of the extremities of the measured line, with the like quantity determined by astronomical observation; but as no such observations had been made in any of the instances, the argument could not be carried so far.

There is however good reason to think that the longitudes computed on the assumed spheroid are very nearly equal to the true quantities, at least in all the perpendicular measurements made in England. For all these instances lie very near the meridian of Greenwich; and in that region we know by experiments on which confidence can be placed, that the longitudes determined astronomically agree with the geodetical computation. Thus it follows from what is shown in this Journal for September 1828, pp. 191, 193, that the difference of longitude between Dunkirk and Greenwich, determined experimentally, is almost exactly equal to the same quantity calculated on the given spheroid of revolution; and I shall now add another similar instance in corroboration of my argument.

In the Phil. Trans. 1824, Dr. Tiarks gives the difference of longitude between Dover and Falmouth, determined by chronometers, equal to $25^{l}\ 28^{ll}{\cdot}42$ in time; and the difference of longitude between Falmouth and the observatory at Portsmouth, equal to $15^{l}\ 45^{ll}{\cdot}51$ from a mean of two results:—we therefore have the difference of longitude between Dover and the

the observatory at Portsmouth, equal to $9^{I}\ 42^{II}\cdot91$ in time. Let us now compare this quantity with the result of geodetical computation.

The longitude of Dover has already been calculated in this Journal for September 1828, p. 191; viz.

$$1^{\circ}\ 19^{I}\ 23^{II}\cdot78 \text{ east.}$$

According to the Survey*, the distance of Beachy Head from the meridian of Greenwich is 9808 fathoms; and the latitude being $50^{\circ}\ 44^{I}\ 21^{II}$, the longitude will be found equal to $15^{I}\ 15^{II}\cdot02$ east: wherefore the difference of longitude between Dover and Beachy Head is

$$1^{\circ}\ 4^{I}\ 8^{II}\cdot76.$$

If to this we add $1^{\circ}\ 27^{I}\ 5^{II}\cdot7$, which, by former computations, is the difference of longitude between Beachy Head and Dunnose, we shall get the difference of longitude between Dover and Dunnose; viz.

$$2^{\circ}\ 31^{I}\ 14^{II}\cdot46.$$

According to the Survey†, the distances of the observatory at Portsmouth from the meridian of Dunnose, and from the perpendicular to the meridian, are respectively 3623 and 11083 fathoms. The latitude of Dunnose being $50^{\circ}\ 37^{I}\ 5^{II}$, the distance between the parallels of the two places will come out equal to 11081 fathoms; and as a degree of the meridian at the latitude of Dunnose is 60815 fathoms, we get the difference of latitude equal to $10^{I}\ 56^{II}$, and the latitude of the observatory equal to $50^{\circ}\ 48^{I}\ 1^{II}$. Having now the latitude of the observatory and its distance from the meridian of Dunnose, the difference of longitude will be found equal to $5^{I}\ 38^{II}\cdot45$ eastward. Finally, the difference of longitude between Dover and the observatory will be as follows:

	in arc.	in time.
Geodetically	$2^{\circ}\ 25^{I}\ 36^{II}$	... $9^{I}\ 42^{II}\cdot4$
By the chronometers...	——	... 9 42 ·91
Diff.	...	0 ·51

The geodetical calculation is probably very near the truth: for if we set aside the two first results which Dr. Tiarks has obtained for the difference of longitude between Portsmouth and Falmouth by his two modes of interpolation, because they are in some degree irregular and different from the rest; the difference of longitude between Dover and Portsmouth will come out equal to $9^{I}\ 42^{II}\cdot12$, very nearly the same as on the spheroid. According to the Survey the same difference of longitude is $2^{II}\cdot4$ less than the quantity found by the chronometers.

* Vol. i. p. 307. † Vol. i. p. 334.

nometers. It appears, therefore, that the longitudes, so far as they have been observed, confirm my former argument, drawn from the perpendicular measurements, in favour of the spheroid of revolution deduced from the lengths of meridional arcs. It would be very desirable to add to the instances already noticed, the difference of longitude between Dover and Falmouth which Dr. Tiarks determined by chronometers; but I have not made the calculations requisite to find the geodetical value of the same quantity.

The measurement of portions of a parallel of latitude lately made in France and the north of Italy, may be viewed precisely in the same light as the operations relative to Dover and Portsmouth considered above. A chain of triangles beginning at Marennes near Bourdeaux was carried eastward through France to Geneva, and then continued in the same direction to Padua. By means of the triangles the differences of longitude of the intermediate stations were computed on the supposition that the earth is a spheroid of revolution having its compression equal to $\frac{1}{309}$ or ·00324. The same differences of longitude were likewise determined astronomically by fire-signals observed from station to station. From these operations it was found that the differences of longitude in time between Marennes and Geneva, and Marennes and Padua, are as follows *:

Geodetically	29′	2″·220	—	51′	57″·340
Astronomically	29	1 ·078	—	51	56 ·121
Diff.		1 ·142	Diff.		1 ·219

If the geodetical and astronomical differences of longitude had come out the same without error, the only inference must have been that the earth coincides in its figure with the assumed spheroid. And how much must be abated from the force of this argument, if the errors do not exceed the probable amount of the discrepancies unavoidable in such observations? Every fire-signal is an independent experiment; and every irregularity of observation has its influence in the total result: and hence it must be evident that the accumulated amount of the errors of so many different operations, is not only not improbable, but even that the greatest skill and care could alone have kept it within so small a compass. The measurement of the parallel, therefore, furnishes a strong presumption that the earth is a solid of revolution such as is deduced from the length of the meridional arcs: and as this conclusion follows immediately from a comparison of the experi-

* *Conn. des Tems*, 1829. pp. 289, 290, 291, 293.

mental

mental results, it seems to be the justest and most natural inference that can be drawn from those results.

The matter has, however, been viewed differently. The length of a degree of the parallel computed on the given spheroid is 77835 metres: but if we substitute the astronomical in place of the geodetical amplitudes, we shall have $\frac{1742''\cdot22}{1741\cdot078} \times 77835 = 77886$* metres for the mean length of a degree between Marennes and Geneva; and $\frac{3117''\cdot34}{3116\cdot121} \times 77835 = 77866$ metres† for the mean degree between Marennes and Padua. Now the differences between the mean degrees and the degree on the assumed spheroid, which are considerable, arise solely from the small differences between the geodetical and the astronomical amplitudes, or rather, as we are warranted in saying, from the errors of the astronomical amplitudes. If the small intervals of time, namely $1''\cdot142$ and $1''\cdot219$, by which the geodetical exceed the astronomical amplitudes, may be ascribed either wholly or in part to errors of observation, it will be allowed that the lengths, 51 metres and 31 metres, by which the degree on the assumed spheroid exceeds the mean degrees answering to the astronomical amplitudes, rest either on no authority, or on doubtful authority. Very little stress can therefore be laid on the new compression of the earth deduced from the combination of the mean degrees, viz. 77886 and 77866 metres, with degrees of the meridian already known. It may very well happen that this method of proceeding, instead of bringing us nearer the truth, may lead us away from it. The conclusion that follows directly and naturally from the measurement of the parallel, is in favour of the supposition that the earth is a spheroid of revolution having the compression indicated by the lengths of the meridional arcs.

Feb. 13, 1828. J. Ivory.

XXXII. *On a new Compound of Oxygen and Manganese; with Remarks on Dr. Turner's Memoir on the Oxides of that Metal. By* R. Phillips, *F.R.S. L. & E. &c.*

IN noticing Dr. Turner's "Elements of Chemistry" (Phil. Mag. and Annals, vol. i. p. 379), I have stated it as my opinion in opposition to his, that when peroxide of manganese is heated in sulphuric acid, it is converted merely into deutoxide. In a paper on the oxides of manganese, which Dr. Turner was so good as to send to me, and which has been

* *Conn. des Tems*, p. 293. † *Ibid.* p. 291.

printed in the Phil. Mag. for July and August last, he has again mentioned, that during solution in sulphuric acid the peroxide becomes protoxide; and as the result of further examination, I readily admit the accuracy of his assertion.

I employed in my first experiments, to the best of my recollection, the native oxide of manganese, which occurs, and frequently in masses of great purity, in Warwickshire; this has I believe been regarded as the peroxide of the metal. On repeating my experiments, I soon found, however, that it is not constituted as the peroxide is usually admitted to be; and in prosecuting my inquiries, I discovered that it is a compound of the metal and oxygen, which has not, as far as my researches have extended, been hitherto noticed. This mineral is of a gray colour, the tint of which is not remarkably different from that of the well-known crystallized peroxide; it is, however, less brilliant. It is much harder than the peroxide, does not soil the fingers so much, and is lighter in the proportion of 4·283 to 4·819: when reduced to powder and boiled in water, a trace of muriate of lime is discoverable.

In order to determine the state of purity of the ore, 200 grs. were treated with excess of muriatic acid, 0·64 of a grain, evidently silica, remained undissolved; sulphuretted hydrogen gas passed into the solution of muriate of manganese, threw down a dark-coloured precipitate, which, when washed and dried, weighed 1·03 grain; this yielded a deep blue solution by treatment with nitric acid and ammonia: it was therefore sulphuret of copper, and may be considered either to exist as such in the ore, or as indicating an equal weight of the peroxide. The excess of sulphuretted hydrogen being expelled by heat, the solution was colourless, and gave a perfectly white precipitate with ferrocyanate of potash.

I exposed 200 grains of the powdered ore to a strong red heat in a covered platina crucible for an hour; the loss of weight was 26·55 grains, and the mean of three experiments gave 26·52, or 13·26 per cent. As it is stated by Dr. Turner and other authorities, that peroxide of manganese, similarly treated, loses 12·122 per cent, I entertained no doubt that the ore under examination was peroxide; for the difference of 1·14 might readily be attributed to error of operation and a little accidental moisture. I next determined the quantity of oxygen separable from the ore by solution in sulphuric acid; for this purpose, I put into a glass retort 2000 grains of sulphuric acid and 200 grains of the powdered ore; the flame of a strong spirit-lamp was applied until gas ceased to be evolved; the retort was then corked, and its mouth kept under water until the sulphate of manganese was cold; the water being

being then suffered to enter, the space unoccupied by it indicated the quantity of oxygen gas remaining in the retort. There were left undissolved 7·8 grains of peroxide of manganese and silica; consequently, allowing one grain for the sulphuret of copper, 191·2 of the oxide were decomposed by the acid.

The capacity of the retort was 18 cubic inches, of which the acid and oxide occupied 5; by deducting 13 from the contents of the air-jar, amounting to 83·5 cubic inches at 60°, we have 70·5 of oxygen gas, to which are to be added 5·5 inches left in the retort, giving 76 cubic inches as the whole of the oxygen gas, yielded by 191·2 of the oxide of manganese. On repeating this experiment, I procured 76·7 inches of oxygen from 192·5 of the oxide; the mean is therefore 39·8 inches = 13·48 grains of oxygen from 100 of the ore. The peroxide of manganese being composed of 44 metal and 16 oxygen, half of which it loses in becoming protoxide, it is evident that the Warwickshire ore is very differently constituted; for as 100 : 13·48 :: 44 : 5·93, which is less than three-fourths of the oxygenth at should have been obtained from peroxide.

In Dr. Turner's paper on the oxides of manganese, already alluded to, a peculiar oxide of manganese is described under the name of Manganite; the principal facts relating to it are stated as follows: "When manganite is heated to redness it gives out 10·10 per cent of water; and the total loss from exposure to a white heat is 13·15 per cent. Deducting from the last number the amount of water, 3·05 remain as the loss in oxygen. The result of this analysis is therefore

Red oxide	86·85
Oxygen	3·05
Water	10·10
	100·00

According to this analysis, manganite contains an oxide of manganese, 89·9 parts of which yield 3·05 of oxygen, on being converted into the red oxide. An equal quantity of pure deutoxide, in undergoing a similar change, should lose 2·997 of oxygen.

"Exposed to a strong red heat and a current of hydrogen gas, 100 parts of manganite lost 19·09 parts in one experiment, and 19·07 in another. The mean is 19·08, and subtracting 10·10 as water, 8·98 remain as oxygen. According to this analysis manganite is composed of

Protoxide	80·92
Oxygen	8·98
Water	10·10
	100·00

"Now as 80·92 : 8·98 : : 36 : 3·995.

"From

"From the result of both analyses, it is apparent that manganite, in relation to manganese and oxygen, is a deutoxide.

"Also as 89·90 : 10·10 : : 4·494.

"The fourth number is so near 4·5, half an equivalent of water, that we may safely regard manganite as a compound of 80 parts, or two equivalents of the deutoxide of manganese, and 9 parts or one equivalent of water."

There are two circumstances in which the Warwickshire ore agrees very nearly with manganite, viz. in the weight which it loses by exposure to a strong, and a low red heat. I have already observed that the first-mentioned oxide loses 13·26 per cent by a strong heat, which differs only 0·11 from that lost by manganite according to Dr. Turner: by a low red heat, the ore now under consideration loses 10·2 per cent; while manganite loses 10·1. There is, however, one fact which proves that the Warwickshire oxide is not deutoxide, as manganite appears to be by Dr. Turner's analysis: it has been already shown that 44 grains of the ore now under examination, lose 5·95 of oxygen by conversion into protoxide; but an equal quantity of a compound of two atoms deutoxide = 80 + 1 water = 9 would give scarcely 4 by the same operation, for as 89 : 8 : : 44 : 4 very nearly.

More particularly to examine the source of the loss of 10·2 per cent at a low red heat, I put 200 grains of the powdered Warwickshire ore, which had been previously dried by steam, into a small coated glass retort, and heated it to redness in an open charcoal fire; an accurately weighed receiver was adapted to the retort; water came over very readily, and a little which remained near the mouth of the retort was expelled by a spirit-lamp, and condensed in the receiver.

The oxide, weighed when cold, had lost 22·4 grains; but the weight of the water was only 10·8 grains: it then occurred to me that part of the loss was owing to the extrication of oxygen, and this I found to be the case; for an ignited piece of wood immediately burnt with a vivid flame on being introduced into the receiver, although no precautions had been taken to receive any gas. I repeated this experiment with the addition of the pneumatic apparatus; the capacity of the retort was 14 cubic inches, and there was obtained a mixture of the atmospheric air of the retort and oxygen gas, amounting to 20 inches. I do not give the results of this experiment with any claim for their accuracy; but if we deduct from the gas even the whole of the atmospheric air of the retort, a considerable portion of oxygen remains; the oxide lost 20·4 grains.

It has been already mentioned that the ore loses 13·48 per cent

cent of oxygen by solution in sulphuric acid; and the water amounting to 5·4 per cent, the mineral consists of

Protoxide of Manganese	81·12
Oxygen	13·48
Water	5·40
	100·00

which are equivalent to

Manganese	63·0
Oxygen	31·6
Water	5·4
	100·0

Its atomic constitution appears to be

Two atoms Deutoxide . .	80	or Manganese . .	63·275
Two atoms Peroxide . . .	88	Oxygen	31·637
One atom Water	9	Water	5·088
	177		100·000

The agreement between the experimental results and the calculated composition seems to me sufficiently near to determine the nature of the Warwickshire ore; and it may be observed, that the atom of oxygen which the water contains would convert the two atoms of deutoxide into two of peroxide.

As Dr. Turner, in his analysis of manganite, does not appear to have suspected that it loses oxygen at a red heat, it seems to me extremely probable that the composition of manganite is similar to that of the Warwickshire oxide; and consequently, about one half of the loss, which is attributed by Dr. Turner wholly to the expulsion of water, is in fact derived from the extrication of oxygen. I am confirmed in the probability of this view of the subject, by the analyses which Dr. Turner has given of psilomelane and the *manganèse oxidé noir barytifère:* if we suppose the former to consist of 69·795 red oxide and 6·018 oxygen, instead of 7·364; and the latter to be composed of 70·967 red oxide and 6·119 oxygen, instead of 7·260 as stated,—the difficulty which Dr. Turner has observed exists in reconciling these oxides with an atomic constitution will vanish; and from the near approach to equality of the atomic weights of oxygen and water, such an error as I have proposed to correct might very readily occur. One circumstance may be observed with respect to the peculiar oxide which I have now described, viz. that it is the only one of five oxides of manganese which has not been formed artificially.

There

There are some other statements in Dr. Turner's memoir, on which I shall offer a few observations. He appears to doubt the existence of a permanent red sulphate of manganese, and to suppose, when it is obtained, that it soon becomes colourless, a precipitate being deposited in it which is the red oxide. "If the (sulphuric) acid," he observes, "which retains an amethyst tint even when cold, be again heated, the red colour speedily disappears; because the red oxide, which is dissolved in small quantity by the sulphuric acid, is then also converted into the protoxide with the evolution of oxygen gas. The red colour disappears gradually even without the aid of heat; for the solution will be found after a few days to be almost and sometimes quite colourless, when a minute quantity of red oxide has subsided to the bottom. On applying a very gentle heat the red oxide is redissolved, and the acid acquires a lively amethyst red colour. It is easy by operating in this way, to obtain satisfactory proof, that a minute portion of red oxide suffices to communicate a rich colour to a considerable quantity of sulphuric acid. The acid may be made to retain the red colour, either by diluting it with water, or by keeping it in contact with undissolved oxide."

I have frequently obtained the red sulphate of manganese, possessing, not merely an amethyst tint, but a most intense and beautiful red; and I have kept such a solution for several months without its depositing any oxide, and without keeping it in contact with undissolved oxide; and dilution with water is so far from preserving the colour of the solution, that it is instantly decomposed by it, and oxide of manganese deposited.

I have examined the circumstances under which this red sulphate is produced; and I shall take this opportunity of stating the method by which it may be formed with certainty and very readily.

Before, however, I proceed to this part of the subject, I will state the experiment upon which I have admitted that when peroxide of manganese is dissolved by sulphuric acid, it is converted into protoxide. For this purpose I used crystallized native peroxide, which contained 1·2 per cent of silica, and 0·6 of sulphuret of copper; of this 150 grains reduced to powder were heated in 2000 grains of sulphuric acid, in the mode already described when treating of the Warwickshire oxide. Without entering into minutiæ, I shall merely state, that the 147·3 grains of pure peroxide which the ore contains yielded 80 cubic inches of oxygen gas, consequently 44 would have given 8·09 grains nearly; a quantity

so

so little exceeding the weight of one atom of oxygen, that upon the result of this and a similar experiment, I have founded the admission which I have made.

I now heated similar quantities of acid and peroxide; but I stopped the operation when about 40 inches, or half the quantity obtained in the last experiment, had come over.

When water was added to the sulphate of manganese, I found that a large quantity of brown oxide of manganese, specifically very light, was diffused through it; it was evidently oxide which had in this respect at least suffered considerable change; it was separated by elutriation from 9 grains of the peroxide employed, and which remained unaltered in its properties; this altered oxide when washed and dried on a sand-heat weighed 58·8 grains.

To determine the nature of this altered oxide, 57 grains were by a strong heat converted into red oxide, by which they lost 6·8 grains, therefore 58·8 the whole quantity would have given 7·01 grains: now as 132 of peroxide lose by this treatment 16 of oxygen, 58·8 would be diminished 7·12; so that the altered oxide is evidently peroxide.

Knowing from previous experiment that red sulphate of manganese is decomposed by a large quantity of water, I repeated the last detailed experiment, but with this variation: I added to the sulphate of manganese only so much water as was sufficient to dilute it enough to allow of its being filtered through paper; by this I obtained, without regarding either the altered oxide, or that which remained unacted upon, five fluid ounces of solution of sulphate of manganese. The colour of this was so intense a red, that when diluted with twice its bulk of water, the mixture was as deep-coloured as port wine, and in tint very closely resembled it. To half the solution I added a wine pint of distilled water, precipitation immediately took place, and when slightly heated, the solution became perfectly colourless, and 3 grains of peroxide were precipitated; after the action of water potash threw down 27 grains of oxide. It has been already mentioned, that the oxide precipitated by water is peroxide; and I have found by repeated experiments, that the protoxide precipitated by potash becomes deutoxide by drying.

Assuming then, as in the former experiment, that 9 grains peroxide and silica remained unacted upon, and that about one grain of the 150 was soluble impurity, we may conclude that 140 of peroxide of manganese by losing 12·7 oxygen, were converted into deutoxide, which formed deuto-sulphate with the acid; so easily, however, is this salt decomposed by water into protoxide and peroxide, that even when employing the small

small quantity mentioned above, the proportion of deutoxide held in solution was to that decomposed, only about as 1 to 10. It is very remarkable, as Dr. Turner has observed, how small a quantity of oxide gives colour to a large quantity of solution; thus from what I have stated, it is evident that about 6 grains of deutoxide impart a colour equal in intensity to that of port wine, to a pint of solution of sulphate of manganese. The red sulphate is also very easily procured by moderately heating the artificial deutoxide in sulphuric acid. It has been already noticed that the deutoxide of manganese is obtained by merely drying the protoxide precipitated by potash; the peroxide is also easily procured by decomposing the muriate of manganese with chloride of lime; the precipitate is so extremely bulky, that a vial holding 1000 grains of water, contained, even when well shaken down, only 60 grains of it. In employing chloride of lime, the solution of muriate of manganese should be as nearly saturated as possible; for the chlorine evolved by excess of muriatic acid, occasions the acidification of a portion of the manganese. I have some reason to suppose that the peroxide thus obtained is a hydrate, containing a very small atomic quantity of water.

With respect to the red oxide of manganese, I would observe that, of all the oxides, it is the only one which suffers no change by the action of heat; the protoxide by absorbing oxygen being converted into it, while all other oxides, by evolving the same element, undergo a similar change: on this account it forms a very convenient standard in analysis; it is obtained of the reddest tint, and with least admixture of purple, by using an artificial peroxide.

In concluding, I will state what appears to be the composition of the oxides and acids of manganese at present known; premising, however, that I have made no experiments upon the two acids.

	Atoms. M. O.	M. O.
Protoxide	1+1	28+ 8
Deutoxide	2+3	28+12
Peroxide	1+2	28+16
Red oxide	3+4	28+10·66
Warwick oxide . . .	4+7	28+14
Manganous acid . .	1+3	28+24
Manganesic acid . .	1+4	28+32

XXXIII. *Reply*

XXXIII. *Reply to* Berzelius's *Attack on* Dr. Thomson's "*Attempt to establish the First Principles of Chemistry by Experiment;*" *noticed in the Philosophical Magazine and Annals, vol.* iv. *p.* 450. *By* Thomas Thomson, *M.D. F.R.S. Regius Professor of Chemistry in the University of Glasgow.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen, Glasgow, February 6, 1829.

YOUR December Number, though published I presume more than a month, has only reached me about half an hour ago. It contains Berzelius's attack upon my character inserted in his *Arberetälre*, for 1827. I had not seen this attack before; but I had heard of it, and been informed of its nature and spirit by several foreign gentlemen, whom I have the pleasure of reckoning among the number of my friends. I had resolved to take no notice of it whatever, being perfectly aware that, as far as my reputation and character are concerned, it would do me no injury. My character and reputation are too well established in my own country, where I am best known, to run any risk from the foul aspersions of the Stockholm Professor. I could only have told him that my feelings were at least as high, and my conduct through life at least as honourable, as his own. I could only have thrown back his foul aspersions with the contempt which they deserved, and demanded that satisfaction which every gentleman feels himself entitled to, when his character has been unjustly traduced. The question was not whether my experiments were accurate or inaccurate; but whether I was an honest man or a scoundrel. Such a question I might surely be pardoned for not thinking it necessary to discuss. My experiments were all made in the laboratory within the walls of the College of Glasgow, and there was scarcely one of them that was not witnessed by more than one competent judge. Indeed more than one-fourth of the salts whose composition I have given in my *First Principles*, were analysed by my pupils. Ample testimony might therefore be produced to authenticate the actual performance of all my experiments. But surely that man must be wofully ignorant of the state of moral feeling in Great Britain, who could allow himself to suppose that a chemical Professor could exist in one of its most celebrated medical schools, capable of setting honour and honesty at defiance. So certain indeed did I feel that not one of my countrymen could for a moment adopt such an idea, that I read the tirade of Berzelius with comparative indifference. And nothing would have induced me to have noticed it at all,

but the remarks which you have attached to it. Had I continued silent after these remarks, it occurred to me that your readers would have supposed me conscious of inaccuracies which I do not believe to exist, and of defects which I had not the spirit to acknowledge.

With respect to Berzelius's observations on my analysis of sulphate of zinc, it is only necessary to state a few facts to enable the reader to appreciate their justice. I sent a copy of my *First Principles* to Berzelius, because I had combated many of his opinions in that work, and thought it right that he should have an opportunity of vindicating himself, if he thought himself unjustly treated. He wrote me some months after that he *could not credit the experiments of a man who did not know that zinc cannot be precipitated from its acid solutions in the cold.* This letter was obviously intended to hurt my feelings, but it was at the same time so foolish that it only excited a smile. It was impossible that he could believe that one who had been actively engaged in chemical investigations for almost thirty years, and who had perused every chemical tract of any value that appeared during that long and most momentous period, could be ignorant of one of the most elementary parts of the science. I had been engaged for years in teaching practical chemistry; and there was at the time a manuscript treatise on analysis written by me, lying in my laboratory, which was open to all my practical students, many copies of which had been taken and dispersed through the country. In that book the most minute directions are given how to separate the constituents of minerals; and oxide of zinc is not forgotten.

On reading Berzelius's letter, I thought that it might silence his malignity if I published a single analysis of sulphate of zinc. I transcribed out of the book where I register my experiments, the first accurate analysis of this salt that I had made. This book still exists: and should any person have the least doubts about the fact, it is open to his inspection. As this analysis had been made without any view to publication, but merely for my own private satisfaction, I cannot conceive any motive that could induce me to falsify the register, unless my object had been to impose upon myself. The weights which I have given, and the quantities of reagents used, are precisely those which I found in my register. The analysis had been made probably a couple of years before I published it, though I do not recollect precisely how long. As for Berzelius's hypotheses about subcarbonates and supercarbonates, I have nothing to do with them. I had only to state

state exactly what I got, and what I doubt not I should get again were I to repeat the analysis.

But this solitary analysis was not the only one from which I deduced the atomic weight of oxide of zinc, though I thought at the time, and still think, that it affords sufficient data for the purpose. I may mention another here, which I made about a year ago, and which was witnessed by one of my practical pupils. 5·25 grains of pure oxide of zinc were mixed with their own weight of flowers of sulphur, and heated in a covered porcelain crucible over a spirit-lamp till the crucible was made red hot. It was kept at that temperature till all sulphur fumes had ceased to exhale. The crucible was then allowed to cool. By this process the oxide was converted into sulphuret of zinc. Its weight was 6·25 grains very nearly. It rather exceeded 6·25, but was not so much as 6·26 grains. Now the atom of oxygen is 1, and that of sulphur 2. It is obvious that the Oxide must have been a compound of

Zinc	4·25
Oxygen	1
	5·25

And the Sulphuret, of	Zinc	4·25
	Sulphur . . .	2
		6·25

When this sulphuret was dissolved in muriatic acid it left a trace of sulphur too small to be weighed, but visible to the eye, and giving out a sensible odour of sulphurous acid when heated. This slight surplus of sulphur was doubtless the cause of the slight additional weight above 6·25 grains.

Such an experiment could leave no doubt about the accuracy of my analysis of sulphate of zinc. The analysis of *blende* which I made last year with great care, and repeated four times, tends still further to corroborate the same thing. As I have sent the result of my investigation of this mineral to the Royal Society of Edinburgh, I do not consider myself at liberty to detail it here.

I had seen from the new edition of Dr. Turner's First Principles of Chemistry, that Berzelius had announced my number for barytes to be erroneous. But I have not yet seen the paper in which this announcement is made, and do not know what the alleged inaccuracy amounts to. I had found the atomic weight of the 4 alkaline earths to be

Magnesia	2·5
Lime	3·5
Strontian	5·5
Barytes	9·75

Had the number for barytes been 9·5 instead of 9·75, there would have existed a very obvious analogy among them all. They would all have terminated in 0·5, or they would all have been multiples of 4 hydrogen. This analogy struck me at an early period of my investigations, and I was anxious to find the weight of barytes only 9·5. The experiments of Berzelius rather favoured the idea; according to his analysis the constituents of sulphate of barytes are

Sulphuric acid	5
Barytes	9·55

But Klaproth's analysis, made with great care, gave

Sulphuric acid	5
Barytes	10·01

But when I mixed together sulphate of potash and chloride of barium, I found in many trials, that 11 of the former and 13·25 of the latter were the weights which decomposed each other completely. When I employed only 13 of chloride of barium (the weight, if barytes be only 9·5), there was always a residue of sulphuric acid in the solution. Even 13·125 chloride left a residue of sulphuric acid; showing clearly that the weight of barytes is more than 9·625.

Berzelius, in the French edition of his tables published in 1819, gives for the weight of barium 17·1386; and under the name oxidum baryticum, we have the four following numbers, which are all obviously multiples of the first.

19·1386
38·2772
57·4158
76·5544

In his new table, published since he had an opportunity of seeing my *First Principles*, I observe a vast number of changes. He has abandoned a great deal for which he had formerly stickled; and though he has not had the candour to acknowledge as much, I see the great impression which my views have made upon him. I am uncharitable enough to believe, that it was in order to prevent his countrymen and the Germans from being aware of the benefit which he derived from my labours, that his attack upon me was made. I had touched his selfish feelings, and disturbed those dreams of chemical sovereignty in which he has been evidently indulging. In his new table he gives the atom of barytes

9·5688

This is about $\frac{1}{54}$th part less than my determination. It was impossible that my error could have amounted to 2 per cent. It could not have been greater than $\frac{1}{1000}$dth part at the utmost.

But there is a circumstance of which I was not aware when I de-

I determined the atomic weight of barytes. The muriate of barytes of commerce always contains lead. The reason I take to be, that it is manufactured from the carbonate of barytes of Anglesark, which is probably mixed with some carbonate of lead. I do not recollect whether the chloride of barium which I employed was prepared by myself, or purchased. Supposing it purchased, it was possible that my number might have been affected by the lead present, which would undoubtedly tend to increase the apparent weight of the atom of barytes. To obviate this uncertainty, I purified a quantity of muriate of barytes by passing a current of sulphuretted hydrogen through its solution. It was then crystallized and ignited. With this purified chloride I made several of my practical pupils in succession, at least as many as six of them, make the following experiment: 11 grains of sulphate of potash and 13·25 grains of chloride of barium were dissolved each in a minimum of water. The solutions were mixed, and after standing for twenty-hours were tested for sulphuric acid and barytes, and in no one case was the least trace of either found. I consider these experiments as more satisfactory than if I had made them myself, because the experimenters could have no undue leaning to my numbers. When I see Berzelius's observations, I shall be able to judge whether any additional experiments are necessary.

The only atomic weights given in my *First Principles*, which I have since found to be inaccurate, are the following:

Chromium I stated to have an atomic weight of 3·5. This was merely from analogy. I had determined the atomic weight of chromic acid to be 6·5; and as there were three compounds of chromium and oxygen, I was led to consider them as composed of 1 atom chromium, and 1, 2, and 3 atoms oxygen respectively, which would make the atoms of chromium 3·5. Since that time I have examined the atomic weight of chromium and its oxides with much care. The reader will find the result of this investigation in the Philosophical Transactions for 1827. I found the supposed deutoxide of chromium to be merely the protoxide contaminated with a little chromic acid. The atom of chromium I found to be 4, that of protoxide 5, and that of chromic acid 6·5.

I find the atomic weight of the phosphoric acid which exists in earth of bones and in the phosphate of soda of commerce to be 4·5, and not 3·5 as I state it in my *First Principles*. My number 3·5 was obtained from the analysis of a phosphate of soda which I had prepared myself many years ago in Edinburgh. My stock of this phosphate was considerable, and it was only exhausted in the summer of 1825. On using some phosphate

phosphate of soda from the Apothecaries'-hall for a particular purpose, I was astonished to find that when I mixed 7·5 grains of the ignited phosphate with a muriatic solution of 6·25 grains of calcareous spar and evaporated the mixture to dryness, and digested the dry mass in water, this water contained a quantity of unprecipitated lime. I found that to precipitate the whole lime, it was necessary to employ 8·5 grains of anhydrous phosphate of soda instead of 7·5. From this it is obvious that the acid in the phosphate weighed 4·5 and not 3·5. I extracted a quantity of phosphoric acid from earth of bones and combined it with soda. 8·5 grains of this salt when anhydrous were still necessary to throw down all the lime from the muriatic solution of 6·25 grains of calcareous spar. I made a quantity of phosphoric acid by the slow combustion of phosphorus and subsequent digestion in nitric acid. The atomic weight of this acid was also 4·5.

I think that there exists two different phosphoric acids which have not hitherto been distinguished from each other, one weighing 3·5 and the other 4·5. Stromeyer seems to have encountered the former in his analysis of Cornish hydrous phosphate of iron (*Unternuhunger*, p. 274); and I found it in the phosphate of soda prepared by me many years ago in Edinburgh. I made my phosphoric acid, if I remember right, by dissolving phosphorus in nitric acid; but the atomic weight of the most common phosphoric acid is 4·5.

I have read over carefully the experiments of Rose on phosphuretted hydrogen gas, and have found nothing in them in the least inconsistent with my experiments on the same gas, which were made so carefully that I cannot doubt their accuracy. Rose's conclusions indeed are inconsistent with mine. But I still think my number for phosphorus, viz. 1·5, right. There are undoubtedly three acids of phosphorus, which must weigh respectively 2·5, 3·5, and 4·5.

There is a circumstance connected with the water of crystallization in oxalic acid which I find myself unable to account for. I find that 9 grains of the crystals of this acid saturate 6 grains of potash and precipitate 6.25 grains of calcareous spar dissolved in muriatic acid without leaving any residue. Hence I conclude, as I have stated in my *First Principles*, that these crystals contain half their weight of water. Dr. Prout wrote me, before the publication of my *First Principles*, that he had uniformly found the crystals of oxalic acid composed of

Acid	4·5
Water	3·375
	7·875

This

This information induced me to make the experiments stated in the note (vol. ii. p. 103). Dr. Prout wrote me after the publication of my work, that he still found the crystallized oxalic acid as he had stated. On receiving this letter I requested my assistant, Mr. Andrew Steel, a chemist of much practical experience, to repeat my experiments and give me the result in writing. His experiments agreed exactly with mine to the hundredth of a grain. I am unable to account for this circumstance, and wish much that some other individual would repeat this experiment, and tell us on which side the error lies. Is it possible that two varieties of crystals of oxalic acid occur in commerce? Those that I first tried I had prepared myself; but I afterwards bought acid, and found its composition just the same.

I have been long aware of the malignant feeling which Berzelius harboured with respect to me, and had even got notice of some attacks which he had sent to certain foreign journals; but which the editors had refused to insert. Neither am I ignorant of the origin of this malignant feeling; though I do not pretend to be less of the *genus irritabile* than other people, I must acknowledge that I have viewed the conduct and the attacks of Berzelius with great indifference. I never had the pleasure of meeting with him, and was thoroughly satisfied that he had formed a very erroneous idea both of my character and conduct. It was not against me, but against a man of straw of his own creation, that the attacks were made. I formed a very early resolution not to retaliate, and I still intend not to deviate from that resolution. I shall continue to avail myself of all Berzelius's experiments, and still use the privilege of calling in question his theories and hypotheses when I think them erroneous. But I shall continue to speak of him, as I have always done, with that respect for his talents and industry which I feel; and allow no improper conduct on his part to drag me into any thing which would derogate from the rank which I am conscious of holding as a man of science and of upright conduct.

I am, Gentlemen, your humble servant,

THOMAS THOMSON.

XXXIV. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

June 19, 1828 (continued).—"EXPERIMENTS and observations on electric conduction," by William Ritche, A.M., F.R.S.

According to the modern theory of electricity, metallic bodies, far from attracting the electric fluid, as is commonly believed, are, of all bodies

bodies, those which have the least attraction for that fluid; and being the best conductors for it, are entirely passive during its transit through them. In confirmation of these views, the author describes experiments in which the electric spark was found to have penetrated through the side of a glass globe, blown to an extreme degree of thinness. An electric jar, from which the air had been partially exhausted, could not be made to receive so high a charge as when the contained air was of the usual density, and when entirely exhausted, could not be charged in any sensible degree: when filled with condensed air, on the other hand, it contained a higher charge than before. The heated, and consequently rarefied air surrounding a red hot iron rod is found to conduct electricity with great facility. The same property is observed in the flame from a blow-pipe, which may be regarded as a hollow cone, containing highly rarefied air: as also on a larger scale in that of a volcano. Sir H. Davy had concluded from his experiments on voltaic electricity, that the conducting powers of metals are diminished by heat: but Mr. Ritchie infers, from several experiments which bear more directly upon the question, that the metals afford no exception to the general law, that in all bodies heat increases the conducting powers; and explains the apparent anomaly in Sir H. Davy's experiments, by the dissipation of the electricity by the rarefied air surrounding the heated metals which were used as conductors. He concludes his paper by describing an experiment, which appears to establish, in respect to this law, a striking analogy between the electric and magnetic influences.

"Observations on the chemical nature of urinary concretions, particularly of those contained in the collection belonging to the Norfolk and Norwich Hospital," by John Yelloly, M.D., F.R.S.

The account given by the author of his examination of the urinary calculi contained in the Norwich collection, the total number of which is 649, relates more particularly to those which have been either purposely divided, or accidentally broken in the extraction, and which amount altogether to about 330. He gives a tabular view of the results of his analyses of these calculi, and states, in the order of their occurrence from the centre, the consecutive deposits of the different materials of which they are composed. About one half of the specimens consist only of one description of substance, and the remainder are formed of alternating layers, more or less numerous, of most of the substances which enter into the composition of human urinary calculi. The distinction between the lithic acid and lithate of ammonia, though generally recognised abroad, was scarcely attended to in this country, until noticed by Dr. Prout. The lithic calculi form, as is usual, the most numerous class of concretions in the Norwich collection, where they amount to nearly a third of the whole number; and if the number of those containing either lithic acid or lithate of ammonia as a nucleus, be taken into account, it will appear, as already observed by Dr. Prout, that not less than two thirds of all urinary calculi either consist of the lithates, or have those substances as their nuclei: whence it may be inferred, that a large proportion of them probably owe their existence to the previous formation

mation of such a nucleus. The deposition of the phosphates is not followed by that of the other materials. The oxalate of lime is the only substance entering into the composition of urinary calculi, which is ever found in the form of distinct and specific crystallization; and it then forms what is called the mulberry calculus. The author is led from his observations, to suspect that carbonate of lime, although rarely found in a separate form in calculi, is not an unfrequent concomitant of phosphate of lime. With the assistance of Dr. Prout and Mr. Faraday, he ascertained the presence of carbonate of lime in some of the specimens which were not previously supposed to contain it. This result was also confirmed by the analyses of several specimens of calculi from the collection in the Hunterian Museum, and also from the Museum of Guy's Hospital, which he was permitted to examine.

The author is in hopes of being able to make some additions to this communication, if he can obtain permission to divide some of the remaining calculi in the Norwich collection, so as to give to the Society the result of the whole analysis.

"On the limits of the pulse in the arteries of the human body," by Lacon Wm. Lamb, M.D. Communicated by Dr. Roget, Sec. R.S.

The limitation of the pulse to a certain portion of the vascular system, has been usually ascribed to the dilatation of the arteries consequent upon the systole of the heart. If a fluid be injected into an elastic tube, part of the fluid will move forwards in the direction of the canal, while another part will remain to distend the tube, being detained by the various causes of retardation to its passage. If the injection intermit, the detaining force, bearing always a fixed relation to the velocity, will intermit also, and the fluid that remains will now be pressed forwards by the elastic parietes of the tube: it is, however, opposed in its turn by a resistance proportional to its velocity, and consequently a permanent tension is maintained throughout the vessel. The fluid which remains during the injection increases with the length of the tube, for the resistance increases with that ratio: hence, the velocity due to the injection must diminish, and that generated during the intermission must increase, as we increase the length of the canal. These velocities tending to equality will ultimately become equal, provided the tube be of sufficient length, and the result will be an uniform mean velocity.

The principles now stated are considered by the author as strictly applicable to the circulation of the blood, which receives intermitting impulses from the action of the heart: hence arise inequalities of pressure, and variations of velocity, producing that succession of dilatations of the vessels which is termed *pulsation*. The author then enters into a mathematical investigation of the length necessary in given vessels to equalize the velocities and the pressures, and endeavours to show that the point of equality determined from these data, lies within the limits of the arterial system. The calculations are founded on the assumption, that in arteries of different sizes the perpendicular pressure on their walls varies as the area of their sec-

tion, and that the time of the heart's systole is nearly the half of the whole time of a pulsation; and upon the formula given by Dr. Young in the Philosophical Transactions for 1808, for estimating the friction of fluids moving in pipes: in the application of that formula the mean dimensions of the circulating vessels are assumed as in Dr. Young's Croonian Lecture, published in 1809. He thus arrives at the conclusion,—that the motion of the blood becomes uniform at the 26th division of the arteries, reckoned from the aorta; and that at this point, the pressure, as measured by the corresponding heights, is reduced from 90 to 80 inches.

As there are cases on record of universal venous pulsation, the author pursues the inquiry into the mechanical conditions, which tend to favour the production of this effect: and also applies the results of the analysis to the explanation of the throbbing, or extension of the pulse into parts where, in a state of health, it is not met with, which accompanies phlegmonous inflammation.

"On the mutual action of sulphuric acid and alcohol, and on the nature of the process by which ether is formed," by Henry Hennel, Esq. Communicated by W. T. Brande, F.R.S.

The most abundant product resulting from the mutual action of sulphuric acid and alcohol, without the application of heat, is the sulphovinic acid: but on distillation, this peculiar product disappears, and ether is formed: and it becomes a question what part the sulphovinic acid plays in this process. In opposition to the assertion of Messrs. Dumas and Boullay,—that this acid is not concerned in the production of ether, the author contends, that whenever ether is formed, it is in consequence of the decomposition of the sulphovinic acid. He obtained ether from this latter fluid by distillation, when neither sulphuric acid nor alcohol was present. But if a certain quantity of water has been previously added, the sulphovinic acid is resolved into alcohol and sulphuric acid, and no ether is obtained: whereas, during the distillation of ether in the ordinary way, the sulphovinic acid is reconverted more or less entirely into sulphuric acid. Hence he infers, that the formation of the sulphovinic acid is a necessary and intermediate step to the production of ether from alcohol and sulphuric acid. As ether may be formed from alcohol, by the intermedium of sulphuric acid, so, by the same intermedium, may alcohol be obtained from ether, sulphuric acid being formed in either case, according to the mode of combination of the hydrocarbonous base. This theory is also illustrated by the employment of olefiant gas as the hydrocarbonous base; for, by combining this gas with sulphuric acid, we may form sulphovinic acid, from which we may obtain at pleasure, by varying the circumstances of the decomposition, either alcohol or ether.

LINNÆAN SOCIETY.

Nov. 18.—Read Notices of several Land and Fresh-water Shells new to Great Britain, with occasional Observations, by J. G. Jeffreys, Esq.

Dec. 2.—Read a Description of an undescribed species of *Phasianus*, by Mr. Benjamin Leadbeater, F.L.S.

Two living specimens of this splendid bird, which is from the mountains of Cochin China, were presented by the King of Ava to Sir Archibald Campbell, and by him to the Countess Amherst, who succeeded in bringing them alive to England; but they died shortly after their arrival. One of the preserved specimens, which now forms part of the collection of Mr. Leadbeater, was exhibited at the meeting. The species has been named *Phasianus Amherstiæ*.

Jan. 20.—Read "Descriptions of the new genera and species of the class *Compositæ* belonging to the Floras of Peru, Mexico, and Chili," by Mr. David Don, Libr. L.S.

Feb. 3.—Read Some observations on the *Common Bat* of Pennant, with an attempt to prove its identity with the *Pipistrelle* of French authors, by the Rev. Leonard Jenyns, M.A. F.L.S.

The Common Bat of our country having been referred by every systematic writer from the time of Pennant to the present day to *Vespertilio murinus*, Linn., Mr. Jenyns points out the great difference between our bat, and that to which continental authors give the Linnæan name, both in colour, general appearance, the shape of the auricle and its operculum; and in the relative dimensions and absolute size. He considers the species of the foreign authors to be the *V. murinus:* and he states that all our English writers, including Griffith and Fleming, have only repeated Pennant's description, or translated Linnæus's specific character. He then concludes that our common bat is the *Pipistrelle* of Daubenton and succeeding writers.

The author adds some interesting observations on the habits of Bats: each species, he finds, have their peculiar place of concealment; also that the same increase of temperature which will revive them from torpidity early in the winter, will not have that effect (nor will even a much higher one) after they have been rendered completely torpid by severe frost.

Feb. 14.—The reading of Mr. Don's "Descriptions of the new genera and species of *Compositæ* from Peru, Mexico, and Chili," was continued.

ASTRONOMICAL SOCIETY.

Nov. 14.—A paper, by Mr. James Epps, was read, containing "Tables for readily ascertaining the azimuthal deviation of a transit instrument from the meridian, by observed transits over the vertical it describes; with the method of reducing these observations to the meridian, and of determining the exact state of the clock in respect to sidereal time."

There was also read Part I. of a communication from Captain P.W. Grant, of the Bengal Survey Department, on what he considers "some new and improved methods of finding the longitude."

The following extract from a letter addressed to J. F. W. Herschel, Esq., President, by the Astronomer Royal, was next read:—

Royal Observatory, Greenwich,
November 5th, 1828.

"The comet was, I believe, seen, for the first time at this place, last night. You probably, with your powerful telescope, may already have seen it. Should that not be the case, you will be glad to hear of its appearance. Mr. Richardson first perceived it with a 30-inch telescope, of large aperture, applied to the western equatorial."

Nov. 4th. Mean time, $11^h\ 13^m\ 22^s$ { $\mathcal{R}$ $22^h\ 47^m\ 49^s$. D $23°\ 39'\ 27''$ N.

Lastly, There was read the following communication from James South, Esq.:—

"Thursday Evening, October 30th.—Right ascension, $23^h\ 13^m$; declin. $+25°\ 43'$; a luminous patch in the field of the transit instrument, but so extremely faint, as to be invisible, unless the eye be directed to another part of the field. The five-feet equatorial exhibits it with difficulty; but the night is hazy. Its place accords so closely with the calculated place of Encke's comet, and its appearance so reminds me of that which Encke's comet put on, when I first detected it at Passy, in the summer of 1825, that I consider it no other than that body. I communicated my sentiments the following morning to Mr. Troughton, and (as I believe) to Mr. Baily also.

"Monday, November 3rd.—Directed the equatorial to R.A. $23^h\ 13^m$; declin. $+25°\ 43'$; but the nebulous spot seen on the 30th cannot be perceived. The night, however, is perhaps a little hazy. About half an hour subsequent to this, the sky became beautifully clear; and on placing the equatorial on the spot which Encke's comet should occupy, according to his ephemeris, a nebulous spot was seen exactly in the centre of the field, of the same figure as that perceived on the 30th. It was, however, now so distinct, as to be seen by Captain Beaufort and myself without difficulty. Lord Ashley, Mr. Baily, and Professor Moll, were present at the time. Clouds, however, suddenly supervened, which prevented its meridian passage being observed: nor was it visible during the more advanced period of the night.

"Tuesday, November 4th.—Right ascension, $22^h\ 49^m$; declin. $+23°\ 48'$; three stars seen in the field of the equatorial, two of them forming a double star of the 6th class, of the 9 and $9\frac{1}{2}$ magnitudes (we will call them A and B), angle of position, about 70° south following: distant, and at an angle of 20° or 30°, with the larger of the two first-mentioned stars, is another star of the 10th magnitude, which we will denominate C. About a minute north of A, and nearly in a line with its companion B, and preceding A three seconds of time, is a faint nebulous spot. The equatorial was now placed at R.A. $23^h\ 13^m$; declin. $+25°\ 43'$; and at R.A. $22^h\ 53^m$; declin. $+24°\ 14'$; but no nebula can be detected in either place, although the night is remarkably fine. By the transit instrument, the right ascension of the presumed comet was $22^h\ 48^m\ 50^s$. At $1^h\ 15^m$ sidereal time, it had materially altered its position relatively to the neighbouring stars, being considerably to the south of the star

star A, and nearer to C than to A. It is therefore, beyond all doubt, a comet; and as its place coincides so exactly with the calculated place of Encke's comet, it can be no other than *it*.

"Wednesday, November 5th.—This evening, at Slough, the comet was seen in the 7-feet, the 10-feet, and 20-feet reflectors, by Mr. Herschel, Lord Ashley, Dr. Wallich, and myself; since which time I have frequently seen it with the 5-feet equatorial; and on Wednesday night last, the moon being seven days old, and but a few degrees distant, it was still visible, and was seen by two of my visitors and myself."

Dec. 12.—The first paper read this evening was the following: Occultations of Aldebaran by the Moon, in the year 1829, computed for ten different observatories in Europe, at the request of the Council of this Society, by Thomas Henderson, Esq. of Edinburgh, and Thomas Maclear, Esq. of Biggleswade, in Bedfordshire.

The object of the Council, in procuring these computations, has been to induce astronomers to look out for the occultations, with a view principally to determine whether Aldebaran will *appear projected on the face of the moon*, as has frequently been observed in former occultations of this star.

The next paper was "On the determination of the Constant of Aberration of Light, from 4119 observations made at the Royal Observatory at Greenwich, during the years 1825, 1826, 1827, and 1828, with the two mural circles of Troughton and Jones, by Mr. William Richardson." The author remarks, that, after the great labour bestowed on the subject of aberration by those eminent astronomers, Bradley, Delambre, Bessel, Lindenau, Brinkley, and Struve, it might appear superfluous to attempt the exact determination of an element, the amount of which is known within such small limits. However, as this attempt has never been made from the Greenwich observations, since the time of Bradley, and as the two mural circles erected there, together with the method now adopted of observing alternately by reflection, afford such powerful means of detecting the most minute variations in the apparent motions of the heavenly bodies, the author conceived that the results of observations made under such favourable circumstances might be highly acceptable to the practical astronomer. With this view he has undertaken the reduction of upwards of 4000 recent observations of 14 of the Greenwich stars most favourably situated for determining this element, those having been selected which are the most affected by aberration, and the least affected by refraction; whereby the errors of observation have the least possible influence on the result. The final result (giving equal weight to each observation) obtained by Troughton's circle is $20''{\cdot}505$, and by Jones's circle $20''{\cdot}502$; and, for the sake of round numbers, Mr. Richardson proposes to adopt $20''{\cdot}5$ as the most probable value of the constant of aberration. This value is somewhat greater than that proposed by Dr. Brinkley and Mr. Struve, and recently adopted by this Society; but rather less than the values deduced by MM. Bessel and Lindenau.

Lastly, there was read a paper by Mr. James Epps, upon the inclination

clination of the axis of the transit instrument, with accompanying tables.

A letter was read from Dr. Lee, requesting the Society to accept of the two-feet meridian circle, divided on gold, by Troughton, for the late Rev. Lewis Evans.

A letter was also read from Dr. Wollaston, presenting to the President and Council of the Society his fine triple object-glass achromatic telescope, made by the late Mr. Peter Dollond, in the year 1771, and which he had himself adjusted agreeably to the method laid down by him in the Philosophical Transactions for 1822.

FRIDAY EVENING PROCEEDINGS AT THE ROYAL INSTITUTION.

Jan. 23.—Mr. Brande gave an account of the supply of water to the metropolis by the various companies established for that purpose. He gave a particular account of the districts supplied by each company; of the quantity of water given to each householder; of the advantages of the mode of supplying adopted in London; of its effects as a cleanser of the town; and then entered into experimental details upon the required purity and salubrity of the water, and the methods which have at various times been proposed and adopted for the correction of water not possessing these properties.

The library-table was supplied with a variety of interesting matter according to custom.

Jan. 30.—Mr. Burnett gave some observations, original and select, on vegetable metamorphosis. The most useful and interesting part of this subject related to those applications of art to nature, by which the wants of man could be more abundantly supplied than in the natural state; and amongst these the conversion of leaf buds into flower buds, and the nature of the ordinary vegetables used at tables, very different indeed from their nature in the wild state, were pointed out, and philosophically considered.

The beautiful appearances of colour produced upon steel-plates, by Signor Nobili, were also exhibited and generally explained. These appearances are the effects produced by the poles of the Voltaic pile, which, as M. Nobili states, under certain circumstances occasion the precipitation of matter from solutions according to very peculiar laws.

Feb. 6.—Mr. Green read a paper On the study of ancient coins in connection with history; in which he traced the progress of the manufacture of coin, and proposed a new method of arranging coins in illustration of the history of ancient times.

Feb. 13.—Mr. Faraday entered into a statement of Mr. Brown's discovery of the existence of active molecules in organic and inorganic matter; and in addition to the matter contained in the paper published in our Magazine, vol. iv. p. 161, related several new observations; stated more minutely the manner in which the influence of known and ordinary causes had been as much as possible excluded, and corrected the erroneous opinions which had gone forth relative

relative to what Mr. Brown had been supposed to have said or implied.

Feb. 20.—Mr. Ainger resumed and completed the considerations relative to pendulums, which he commenced in the last season; upon this occasion considering principally the variation of time in the vibrations dependent upon the difference in extent of the arcs through which the pendulum passed, and also the variations produced by temperature. The corrections for both these were explained and illustrated.

SOCIETY FOR THE ENCOURAGEMENT OF ARTS, MANUFACTURES, AND COMMERCE.

We feel pleasure in giving additional publicity to the following circular, addressed to the Members of the Society of Arts, by the Secretary to that useful Institution.

The Society of Arts having taken into consideration the advantages that would probably accrue from occasional meetings for dissertations on subjects connected with the Arts and Manufactures of the country, illustrated by ancient and modern specimens, has determined to appropriate to this object *Seven Evenings during the present Session.* Ancient and modern Pottery and Porcelain have occupied the first two evenings; and the subjects proposed for illustration on the others are, the Arts of Stereotype Founding and Printing, and of Casting in Plaster of Paris, and the manufactures of Glass and of Paper. The preparation of the Essay to be read on each evening has been confided to the Secretary, who will be happy to receive either written or verbal communications illustrative of any of the above subjects.

It is evident that much of the interest and instruction expected from the proposed meetings, will depend on the abundance and quality of the specimens by which each subject shall be illustrated. Applications have already been made to several individuals, both in and out of the Society; and the uniform liberality with which they have been met is a gratifying proof of the interest taken in the plan, and a presumption that other members of the Society will be equally willing to contribute curious and interesting specimens, either directly or more remotely connected with the topic of each evening's discussion. The Special Committee of Chairmen, to whom the details of the arrangement have been intrusted, request that such members as are disposed to contribute information or the loan of specimens, will notify the same to the Secretary at their earliest convenience, in order that measures may be taken by which, with the least inconvenience to them, the Society may in the most advantageous manner avail itself of their liberality. The Society will also feel obliged by the loan of any articles that will add to the interest of these meetings; characteristic specimens of natural substances, especially of those that form the raw materials of the arts and manufactures of the country, tools, instruments, and models of machinery, samples of new and beautiful fabrics, fine works of art, books, and prints, will be particularly acceptable. It is requested that all such articles may, if possible, be sent the day before the meeting, in order that they may be properly arranged.

XXXV. *In-*

XXXV. *Intelligence and Miscellaneous Articles.*

COMBINATION OF ARSENIC ACID WITH CERTAIN KINDS OF SUGAR.

A SOLUTION of pure arsenic acid, mixed with common sugar powdered, becomes in some hours of a reddish colour, then of a magnificent purple. The experiment succeeds in the cold, and without the presence of light. The sugar of fruits and that prepared from starch produce similar effects. Sugar of milk gives a reddish brown colour, and sugar of manna (mannite) a brick red; the sugar of urine and oil of wine produce no colour. No similar phænomenon is observed if the arsenites or arsenious acid be substituted for arsenic acid. Phosphoric acid, which has much analogy with the arsenic, does not colour sugar at all; they may by this even be distinguished from each other. M. Elsner, the author of these experiments, found that in the purple solution the sugar is combined with arsenious acid.—*Journal de Pharmac.* Nov. 1828.

ACETIC ACID FROM CINCHONA.

M. Robiquet has observed that the true bark of the cinchona submitted to dry distillation, yields very concentrated acetic acid at a very moderate heat; and according to M. Virey, many other vegetable substances yield the same product.—*Ibid.*

SEPARATION OF VOLATILE OILS.

M. Bonastre has succeeded in separating several mixtures of volatile oils; by gradual distillation, oil of cloves is easily separated from oil of turpentine. Oil of sassafras yields crystals of oxalic acid by the action of nitric acid, which is not attainable from several other oils. The caustic fixed alkalies retain the oil of cloves, whilst they part with oil of sassafras by distillation; the alkalies even when they solidify oil of cloves or other volatile oils, do not alter them, for they may be separated unchanged by the action of an acid.—*Ibid.*

ACTION OF PERCHLORIDE OF CYANOGEN ON WATER.

M. Serullas has determined that when the perchloride of cyanogen, which he discovered, is mixed with water, the latter is decomposed, and muriatic and cyanic acid are obtained; the fluid saturated with potash, gives muriate and cyanate of potash, two salts which are readily separable by crystallization, the cyanate being much less soluble than the muriate. When also a solution of perchloride of cyanogen is evaporated to dryness to volatilize the muriatic acid, there is obtained a very white and well crystallized cyanic acid; it is sparingly soluble, and reddens vegetable blues.—*Ibid.*

AMYLIC ACID.

This acid, discovered by M. Tinnermann, is thus prepared: mix well and put into a retort equal parts of starch and black oxide of manganese, so as to fill one-fourth of it, and then a third part of water

water is to be added and made to moisten the mixture equally; a receiver and safety tube are to be adopted, and then heat is to be applied until the mixture nearly boils; 3 parts of muriatic acid are now to be gradually added; when the effervescence is over, and the contents of the retort are nearly dry, the distillation is to be stopped to prevent any impure matter from distilling over. The product is impure amylic acid, scarcely coloured; and though it contains no hydrocyanic acid, it has a strong smell of bitter almonds; to free it from muriatic acid the liquid is to be saturated with carbonate of lime filtered, evaporated till a pellicle forms, then allowed to cool and crystallize, and when the crystals of amylate of lime have been separated, the mother liquor is to be further concentrated. The crude amylate of lime is to be purified by further crystallization, until it does not precipitate nitrate of silver; then mixing 100 parts of these crystals with 73 of sulphuric acid, diluted with twice its weight of water, and distilling nearly to dryness, an aqueous solution of amylic acid is obtained.

This acid is sour, reddens vegetable blues, readily evaporates by heat, produces a sharp odour resembling that of hydrocyanic acid; and combines with bases to form neutral salts, most of which are deliquescent, and all are readily soluble. Some of its salts contain water of crystallization, and others none. The dry salts are decomposed by heat into carbonates and charcoal. The sulphuric, nitric and muriatic acids decompose these salts, producing carbonaceous precipitates. The neutral salts reduce nitrate of silver and muriate of gold. Amylic acid dissolves carbonate of lime with effervescence. The solution evaporated yields octangular crystals, mingled with plates. The salt is soluble in 4 parts of water, and scarcely in alcohol; its solution is decomposed by oxalate of potash. It consists of 42·16 lime, and 57·84 of amylic acid; the amylate of barytes crystallizes in four-sided prisms, and contains 37·29 barytes, 29·24 amylic acid, and 13·47 water; the salts of potash, soda and ammonia are deliquescent. Amylic acid is composed of 2·5 carbon and 3 oxygen.—*Bull. Univ.; and Institution Journal,* Jan. 1829.

DECOMPOSITION OF BORACIC ACID BY HYDROGEN.

M. Varvinsky passed hydrogen gas over crystallized boracic acid, heated to redness in a porcelain tube; the boracic acid was vitrified, and of a brown colour. The mass was boiled in distilled water, and left an olive-coloured flocculent matter: this residuum separated from the supernatant fluid by decantation, washed and heated on platina foil was converted into a vitreous mass; another portion treated with hot nitric acid was dissolved, and occasioned the evolution of nitrous vapour, and the solution gave a precipitate with barytes water; this olive-coloured substance was therefore brown.—*Hensman's Repertoire de Chimie,* Oct. 1828.

RHUTENIUM AND PLURANIUM,—NEW METALS.

Professor Osann digested 100 grammes of crude Uralean platina in

nitromuriatic acid, the acid was added as long as solution occurred; the solution was filtered, and the insoluble residuum after drying was treated with caustic potash and evaporated to dryness; crystals of nitre were afterwards fused with it; after cooling, the fused mass was washed with water, suffered to subside and decanted. The insoluble portion was again treated with potash and nitre; and these operations were repeated until the matter entirely lost its metallic lustre; the various solutions were mixed, and then nitric acid was added slightly in excess. A deep black powder was precipitated, and a strong smell of osmium was given out; it was put into a retort and distilled, in order to extract the osmium. When half the fluid had come over, it was suffered to cool. After 24 hours, long prismatic crystals, of a reddish white colour and remarkable lustre, were formed in the solution: water was added; this dissolved the crystals, and the solution was poured into a capsule and evaporated to recrystallize. The salt being placed upon a bit of charcoal and heated with the blowpipe, a part of it sublimed; while another portion was reduced to a metallic globule: some of the crystals were dissolved in water, a little muriatic acid was added, and a bar of zinc was put into the solution. Some other crystals were heated in a glass tube sealed at one end; they sublimed without leaving any residue or emitting any smell. Oxide of osmium would have been raised in vapour by distillation; the oxide of tellurium, bismuth and antimony, would not have dissolved in water. For these reasons Professor Osann concludes that these crystals were the oxide of a new metal, to which he purposes to give the name of Rhutenium.

Professor Osann has also discovered another metal in the same residuum, insoluble in nitric acid: to this he proposes to give the name of Pluranium; it is more abundant than rhutenium.—*Ibid.*

SULPHURET OF SILICA.

M. Buchner mixed by trituration equal parts of silica and sulphur; the mixture was put into a small glass retort and exposed to a moderate heat for several hours. The product was a porous gray mass, from which caustic potash separated only a minute portion of sulphur, and left a few grains of quartz. The alkaline solution deposited a fine black powder, which is the compound mentioned.—*Ibid.*

MAGNESIA AND GLUCINA REDUCED TO THE METALLIC STATE.

M. Bussy gives the following account of the reduction of these earths. I have succeeded in separating the metal from magnesia, by the action of potassium upon chloride of magnesium heated to redness in a porcelain tube. The magnesium separated by washing, had the appearance of small brown scales, which pressed by a pestle in an agate mortar left a metallic trace, the colour of which resembled that of lead. Diluted nitric acid does not attack this metal; muriatic acid and potash dissolve it. It burns with difficulty even at a high temperature, and yields magnesia by the combustion.

Glucina treated in the same manner also yielded a metal. In order to

to obtain it glucina is employed, prepared by M. Vauquelin's method; it is to be dried, mixed with sugar and flour, and calcined. It yields a compound of glucina and finely divided charcoal; this mixture is to be put into a porcelain tube, and chlorine passed over it. The chloride of glucinum formed, collects at one end of the tube in the form of white brilliant needles. It is mixed with chloride of iron, from which it is separated by distilling it in a glass tube; the two chlorides separate; the chloride of glucinum is afterwards treated with potassium and heat; potash is formed, and glucinum developed; when treated with water, the potash formed and the chloride of glucinum unacted upon are dissolved, and the glucinum is left.

Glucinum is of a brown colour; it is in small scales; nitric and muriatic acids dissolve it readily. When thrown into a red hot platina crucible it burns vividly, and oxide is produced; the metal of the crucible is much altered: the chloride of glucinum is extremely deliquescent; when thrown into water it occasions a hissing, similar to that of red hot iron when similarly treated.—*Ibid.*

TEST FOR OXYGEN IN A GASEOUS MIXTURE.

M. Kastner considers that protoxide of iron is the most sensible test of the presence of oxygen which has ever yet been employed. It is prepared by filling a well stopped flask with hot water; about 1-20th of its weight of recently prepared sulphate of iron is then dissolved in it, and ammonia is added to the solution while hot, and in excess. When this is done, the flask is to be securely closed until the precipitate is perfectly formed; all the fluid is afterwards to be decanted by a syphon, and the precipitate is to be washed with water which has been previously well boiled, and the flask is then to be filled with hot alcohol.

When this protoxide is to be used, it is taken quickly by means of a small spoon, and it is to be put into a vessel nearly filled with water which has been deprived of air by boiling. Into this vessel the gas to be examined is passed; and if it contain 1000dth of its bulk of oxygen, it is indicated by the ochrey appearance of the oxide of iron.—*Ibid.*

CARBON IN PIG IRON.

According to M. Karsten, white pig iron contains more carbon than gray pig iron. The following are the proportions of carbon per cent in pig iron, according to several of his experiments:—

White Pig Iron.

Combined carbon....	0·60	0·81	1·00
Uncombined carbon..	4·62	4·29	4·05
	5·22	5·10	5·05

Gray Pig Iron.

Combined carbon....	0·89	1·03	0·75	0·58	0·95
Uncombined carbon..	3·71	3·62	3·15	2·57	2·70
	4·60	4·65	3·90	3·15	3·65

Bull. Univ. Roy. Inst. Journal.

DISCOVERY OF COAL NEAR LEICESTER.

A report was made in Sept. 1827, by Mr. Francis Forster, mineral surveyor, on the probable existence of coal in the vicinity of Leicester, arising from the supposed extension of the Ashby coal-measures, *under* the new-red-sandstone formation, from Ibstock near Ashby, by way of Bagworth, Desfond, Kirby-Muxloe and Glenfield towards Birstall; thus passing within about two miles of Leicester. The opinions expressed in this report have since been confirmed in great measure by the discovery of a seam of coal, by boring near Bagworth. A detailed extract from the report, accompanied by a sketch of the locality, will be given in our next.

SITUATION, CONSTRUCTION, &c. OF THE BAROMETER REGISTERED BY THE HORTICULTURAL SOCIETY.

Horticultural Society's Garden, February 12, 1829.

For the information of S. S. of Canonbury, I send you the following notes relative to the Horticultural Society's barometer. It has been fully described in a paper printed in the Transactions of the Society, vol. vii. p. 97—99. But as S. S. probably has not seen that paper, I subjoin partly from it what refers to the instrument in question.

1st. Its position is nearly 14 feet above the mean level of high-water in the Thames at Chiswick.

2nd. A thermometer is inserted in the mercury of the cistern to mark its temperature, which is noted at each observation, and for which the necessary corrections are made, as well as for capillary action, and the capacity of the cistern. The former being ·009 inch, which is constantly added; and the latter being one hundredth of the difference between the height of the barometer at the time the observation is made, and 30·136 inches the neutral point (or the level from which the height of the mercurial column was first measured), which is either added or subtracted, according as it may be above or below that point; so that the entry in the register is the actual pressure of the atmosphere at the station as it would be measured by a column of mercury of the temperature of 32° of Fahrenheit.

3rd. 1. The cistern is a covered one; it is turned in mahogany and lined with iron.

2. The proportion which the surface of the mercury in the tube bears to that in the cistern is as 1 to 100; so that a rise or fall of one inch in the former makes a difference of 0·01 inch in the latter.

3. The diameter of the inside of the tube is 0·45 inch. It dips 1·1 inch below the surface of the mercury in the cistern.

4. I am not sure that I rightly understand the two queries of S. S. in his 3rd. § 4. But if they are meant as I take them to be, my answer to the first is, that the point from which the true height is measured, is 30·136 inches; to the second, that the temperature at which this is correct is 60° Fahrenheit.

W. B. BOOTH.

NEW

NEW SOUTH SHETLAND.

Extracts from a letter addressed to George Rainy, Esq., of Demerara, in 1823, by John Hancock, M.D.

"With respect to the *new discoveries*, as they are termed, towards the south pole, I am fully persuaded that Smith's New South Shetland is no other than the land discovered by Gerrard, a Dutchman, more than two hundred years ago. If it be not the same continuous coast, it doubtless belongs to the same Archipelago or cluster of islands.

"Smith having made the land far to the eastward and somewhat northerly, ran down the coast precisely in the direction of Gerard's land-fall, and to within three or four hundred miles of the same, supposing Gerard to have been correct in his reckoning, or in the estimate, I should rather say, of his position.

"I observed some very long and learned discussions in the Literary Gazette, in Blackwood's Magazine, and other publications of 1820, respecting the courses sailed by Cook and other navigators in the Southern Ocean; thence deducing the reasons why this important discovery had never before been made. Not the slightest notice or allusion occurs, however, in these publications, with respect to the land of Gerrard.—I had remarked the omission to Captain M'Pherson of Perth Estate, and to several gentlemen in this vicinity, at the time those publications reached us.

"I did not, however, believe that the real merits of this case would have remained so long concealed from the public. It is indeed difficult to account for this silence; for we can hardly conceive that the editors of those periodicals could be ignorant of Gerrard's discovery, and of the probable identity which I have alluded to, and which is the more striking and conclusive, from the remarkable coincidence in the descriptions by which the two navigators have characterized the physiognomy of the coast; both expressly comparing its appearance to that of the *coast* of *Norway**.

"Gerrard, who having doubled Cape Horn, and passed the Straits of Magellan, was driven under bare poles in a storm for a part of two days towards the south-west, may have *overrated* his *run;* and considering the imperfection of nautical astronomy two hundred years ago, as also that ships in our own time are not unfrequently found under an error of 5 or 6 degrees of longitude, it is more than probable that both Gerrard and Smith have beheld, not merely the same continent or group of islands, but even one and the same point, mountain or promontory, of this Southern Thule.

"In elucidation of Gerrard's discovery, I beg leave to refer you to Dalrymple's collection of voyages and discoveries, London 1770, vol. i. page 94.—The same is cited in the instructions to Perouse, vol. i. page 147.—See also Dunn's Chart of the World on Mercator's Projection, published by Laurie and Whittle."

Essequebo, May, 14, 1823. ———

SCIENTIFIC BOOKS.

Just Published.

No. I., complete in itself, of The Natural History of several new,

* The name of New Norway would doubtless have been more appropriate than the long, barbarous, and sigmoid sound of New South Shetland!

popular

popular and diverting Living Objects for the Microscope, with the Phænomena presented by them under observation, &c., conjoined with Accurate Descriptions of the latest improvements in the Diamond-Sapphire, Aplanatic, and Amician Microscopes; and Instructions for Managing them, &c. &c.; to which is added a tract on the newly-discovered Test Objects. Illustrated by highly-finished Coloured Engravings, from Drawings of the Actual Living Subjects. By C. R. Goring, M.D., and Andrew Pritchard.

An Essay on the Lever; containing a Mathematical investigation of its properties, and numerous examples of its application in the construction of Machines and Implements. By G. G. Ward, machine maker; to whom, as a working Member of the London Mechanics' Institution, was awarded one of the Annual Prizes given by Dr. Fellowes, for having written the best Essay on one of the Mechanical Powers.

The Cause of Dry Rot Discovered; with a description of a Patent Invention for Preserving Decked Vessels from Dry Rot, and Goods on Board from Damage by Heat. By John George, Esq., Barrister-at-Law.

The Manual for Invalids. By a Physician.

METEOROLOGICAL OBSERVATIONS FOR JANUARY 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·20 Jan. 31. Wind NE.—Min. 29·00 Jan. 26. Wind S.W.
Range of the index 1·20.
Mean barometrical pressure for the month ..... 29·708
Spaces described by the rising and falling of the mercury..... 6·080
Greatest variation in 24 hours 0·560.—Number of changes 15.
Therm. Max. 49° Jan. 1 & 4. Wind N.W.—Min. 21° Jan. 23. Wind NE.
Range 28°.—Mean temp. of exter. air 36·13°. For 29 days with ☉ in ♈ 39·98
Max. var. in 24 hours 19°·00—Mean temp. of spring water at 8 A.M. 32°·12

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evening of the 29th ..... 88°
Greatest dryness of the air in the afternoon of the 22nd 52
Range of the index..... 36
Mean at 2 P.M. 68°·2—Mean at 8 A.M. 75·9°—Mean at 8 P.M. 74·2
—— of three observations each day at 8, 2, and 8 o'clock..... 72·7
Evaporation for the month 0·60 inches.
Rain near ground 1·39 inches.

Summary of the Weather.

A clear sky, $2\frac{1}{2}$; fine, with various modifications of clouds, 11; an overcast sky without rain, 14; rain, $3\frac{1}{2}$.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
9	4	30	1	11	14	14

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
7	12	5	0	0	2	$\frac{1}{2}$	$4\frac{1}{2}$	31

General Observations.—This month has been generally dry, cold, cloudy, and windy; and from the 14th to the 25th it was seasonable frosty weather, accompanied with light showers of snow on the 18th, 21st, 23rd, 24th, and 25th.

25th. In the nights of the 19th, 21st, 22nd, and 24th, the thermometer receded to 24 degrees, and in the night of the 23rd to 21 degrees. The icy efflorescences were pretty thick on the inside of the glass windows in the mornings of the 20th, 22nd, 24th, and 25th. The moats and marshes were firmly frozen by the 21st, and skating was eagerly pursued till the 25th. On the 23rd the thermometer only rose 31 degrees in the clear unobstructed sunshine, being only 3 degrees higher than the maximum temperature of the external air in the shade; and in the afternoon water froze in rooms where there were fires; this therefore was a very cold frosty day with a piercing gale from the N.E., and during the twenty-four hours water in an exposed tank froze $1\frac{1}{2}$ inch deep. On the same day in London, the thermometer was 6 degrees lower than it was here, and water froze rapidly at noon in apartments with fires.

At noon of the 25th three currents of wind prevailed, the lower one from the East, the middle one from the North-west, and the upper one from the South. The inosculation of these winds brought down an inch in depth of snow by 9 P.M., which was immediately succeeded by heavy rain, a sudden depression of the mercury in the barometer, and a hard shifting gale throughout the night, which broke up the frosty weather. A difference of $12\frac{1}{4}$ degrees in the mean temperature of the atmosphere of any two consecutive months in the year, is very great, which was the case between the present month and last December; and as it occurred in the coldest season of the year, and with but little difference in the sun's declination, very few persons, however cautious they may have been against the effects of such a change, have escaped what is termed a common cold.

The mean temperature of this month is 3·95 degrees colder than the mean of January for the last 13 years.

The maximum temperature of the air occurred in the nights of the 13th, 17th, and 25th, instead of in the days.

The atmospheric phænomena that have come within our observations this month, are eight gales of wind, or days on which they have prevailed; namely, one from the North, four from the North-east, one from the East, one from the South-west, and one from the North-west.

REMARKS.

London. — Jan. 1, 2. Fine. 3. Drizzly: stormy at night. 4. Stormy. 5. Fine. 6, 7. Clear and cold. 8. Drizzly: sleet. 9. Cloudy. 10. Fine in the morning: cloudy. 11—13. Stormy. 14. Cloudy in morning: fine. 15. Cloudy. 16. Clear and frosty. 17. Cloudy and cold. 18—20. Clear and frosty. 21. Clear and cold, with slight fall of snow at noon. 22—24. Stormy. 25. Clear and frosty. 26. Drizzly in morning: fine. 27. Fine: drizzly at noon. 28. Fine. 29. Foggy. 30—31. Fine.

Penzance. — Jan. 1. Fair: clear. 2. Fair: showers. 3, 4. Showers. 5. Hail: showers. 6. Fair. 7. Clear: fair. 8—10. Fair. 11. Clear. 12—15. Fair. 16. Misty: fair. 17. Fair. 18. Rain. 19. Fair. 20. Fair: clear. 21, 22. Clear. 23. Fair. 24. Clear. 25. Fair: rain. 26, 27. Hail-showers. 28. Fair: showers. 29. Rain. 30. Fair. 31. Clear.

Boston.—Jan. 1. Rain. 2. Fine. 3. Cloudy. 4. Rain. 5. Fine: hail-storm A.M. 6. Snow. 7. Cloudy. 8. Fine. 9. Cloudy: rain at night. 10. Snow: rain at night. 11. Cloudy. 12. Cloudy: rain P.M. 13. Cloudy. 14. Fine. 15, 16. Cloudy. 17. Fine. 18. Foggy. 19. Fine. 20. Fine: snow at night. 21. Cloudy. 22. Fine. 23. Stormy. 24. Snow. 25. Misty. 26. Rain and stormy. 27. Cloudy: rain at night. 28, 29. Cloudy. 30. Fine. 31. Cloudy.

Meteoro-

Meteorological Observations made by Mr. BOOTH at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1829.		Barometer.							Thermometer.							Wind.				Evap.	Rain.			
		London.		Penzance.		Gosport.		Boston $8\frac{1}{2}$ A.M.	London.		Penzance.		Gosport.		Bost. $8\frac{1}{2}$ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
		Max.	Min.	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.										
Jan.	1	29·890	29·854	30·15	30·15	29·88	29·83	29·36	49	36	52	44	49	38	43·5	NW.	NW.	NW.	W.	…	…	…	…	.05
	2	30·016	29·888	30·15	30·10	29·92	29·87	29·50	45	30	52	45	45	39	38	NW.	NW.	NW.	NW.	…	…	…	…	·06
	3	30·028	29·944	30·00	29·98	29·95	29·82	29·60	46	35	52	45	45	39	33·5	W.	NW.	NE.	calm	0·05	·21	…	0·360	…
	4	29·591	29·511	29·90	29·90	29·62	29·50	29·20	46	33	50	46	49	36	38	NW.	NW.	NW.	NW.	…	·02	…	·010	·30
●	5	29·938	29·762	30·00	29·90	29·80	29·68	29·48	39	28	46	39	41	32	35	N.	NW.	N.	E.	…	…	0·620	…	·22
	6	30·049	30·020	30·07	30·05	29·90	29·90	29·22	35	30	40	36	38	35	29·5	N.	NE.	N.	NE.	·05	…	…	…	…
	7	30·071	30·001	30·10	30·00	29·91	29·88	29·77	38	31	41	32	41	35	36	N.	E.	NE.	calm	…	…	…	…	…
	8	29·935	29·911	29·95	29·85	29·81	29·79	29·63	36	31	40	36	37	35	33	N.	E.	NE.	calm	…	·03	…	…	…
	9	29·855	29·674	29·85	29·80	29·75	29·61	29·56	38	32	40	31	40	35	33	NE.	E.	N.	calm	·05	…	…	…	…
	10	29·747	29·678	29·75	29·75	29·64	29·55	29·40	39	29	42	31	41	36	35	NE.	NE.	N.	calm	…	…	…	·040	·42
	11	30·018	29·900	29·85	29·75	29·82	29·72	29·62	35	33	44	32	39	29	34	E.	NE.	E.	calm	…	…	…	…	·11
☽	12	30·069	30·026	29·95	29·90	29·89	29·85	29·81	37	33	42	32	39	36	38·5	E.	E.	NE.	calm	·05	…	…	…	…
	13	30·153	30·113	30·05	30·02	30·00	29·98	29·81	37	31	38	34	39	35	36·5	E.	E.	NE.	calm	…	…	…	…	·06
	14	30·112	30·062	30·10	30·05	29·98	29·96	29·74	37	32	39	34	40	36	32	NE.	E.	NE.	calm	…	…	…	…	…
	15	29·989	29·779	29·95	29·65	29·84	29·70	29·65	37	29	41	29	38	32	37	NE.	NE.	NE.	calm	·05	…	…	·010	…
	16	29·690	29·658	29·75	29·65	29·57	29·54	29·33	32	26	44	38	35	30	31·5	NE.	SE.	NE.	calm	…	…	…	…	…
	17	29·929	29·859	29·70	29·67	29·78	29·66	29·48	32	20	44	38	34	31	30	E.	SE.	NE.	calm	…	…	…	…	…
	18	30·103	30·012	29·85	29·80	29·94	29·86	29·67	32	22	45	38	38	28	30	SE.	SE.	E.	calm	·05	…	·560	·020	…
	19	30·201	30·127	30·05	29·85	30·04	30·04	29·82	39	17	44	40	39	24	25	E.	SE.	NE.	NW.	…	…	…	…	…
○	20	30.114	30·014	30·04	30·02	29·97	29·91	29·75	34	24	42	37	35	30	27	E.	E.	NW.	NW.	…	…	…	…	…
	21	29·976	29·879	29·90	29·88	29·81	29·73	29·72	29	22	36	29	32	24	30	E.	NE.	NE.	calm	·05	…	…	…	…
	22	29·748	29·695	29·75	29·65	29·59	29·52	29·60	31	23	35	27	30	24	28	NE.	NE.	E.	E.	…	…	…	…	…
	23	29·629	29·589	29·75	29·50	29·44	29·40	29·50	29	19	30	28	28	21	25·5	NE.	NE.	NE.	NE.	…	…	…	…	…
	24	29·662	29·613	29·75	29·72	29·60	29·53	29·42	29	20	38	19	30	24	26	NE.	NE.	N.	calm	·05	…	…	…	…
	25	29·702	29·534	29·55	29·45	29·56	29·50	29·42	27	24	48	28	43	31	21·5	E.	SE.	E.	calm	…	…	…	·630	…
	26	29·158	29·088	29·10	29·05	29·08	29·00	28·60	49	36	49	38	47	38	32	SE.	NW.	SW.	E.	…	·04	·840	·090	…
	27	29·221	29·170	29·45	29·20	29·14	29·08	28·88	45	32	46	40	47	35	35	S.	NW.	SW.	calm	·10	…	·295	·020	.67
☾	28	29·625	29·443	29·60	29·55	29·55	29·40	29·04	43	27	47	41	48	34	35	SW.	NW.	NW.	W.	…	…	·200	…	·09
	29	29·606	29·479	29·50	29·45	29·45	29·36	29·60	38	30	48	41	46	34	34	NE.	SE.	E.	calm	…	…	·615	·210	…
	30	29·870	29·574	29·75	29·60	29·79	29·50	29·30	42	34	43	39	43	34	30	NE.	N.	N.	NW.	..	…	…	…	…
	31	30·405	30·187	30·15	30·10	30·20	30·04	29·86	40	23	43	35	43	31	35	NE.	NE.	NE.	E.	·10	…	…	…	…
Aver.:		30·405	29·088	30·15	29·05	30·20	29·00	29·49	49	17	52	19	49	21	32·5					0·60	0·30	3·130	1·390	1·98


Measehole Fig 1
North
Plan
Strings of Quartz
Short Short
Killas
Strings of Quartz
Granite
Cape Cornwall Section
Killas
Quartz
Killas
Quartz
Strings of Short
Plan North
Vein of Steatite
Vein of Steatite
Granite
Vein of Steatite
Gew Grease Section on the line A B
Serpentine
Granite
Serpentine
Granite
Kinance Cove
Section on the line C D
Ser
Steatite
Granite
Ser
Steatite
Granite
North
Village of Gwendra
Kennick Cove
View of the Vein near a (9)
Ser
Steatite
Granite
Section on the line l m
Serpentine
Granite
View of the vein near b
Killas
Veins of Short
Garnsilver
Cove B
Granite
Plan
Rosemodrris
Killas
Granite
View of the Wall A B of Garnsilver Cove.
View of the vein near h
Serpentine
Granite
View of the vein near K
Serpentine
Granite
View of the vein near g
Junction of Granite and Killas in Cornwall.
Clagga Point
Hanover Cove
Killas
Granite intersected by parallel Quartz Veins
Section on the line g h
Section on the line a b
Excavation of the mine
Killas
Adit
Granite
Blackleode
Plan of Carclaze tin mine
North
Black lode
Cross course
Junction between Granite and Killas
Veins of tin
Section on the line l m
Large grained Granite
Fine grained Granite
Section on the line a b
South
Large grained Granite
Tol Pedn Penwith
Plan
North
Large grained Granite
Fine grained Granite
View of the Southern wall of the Cove (o)
Fine grained Granite
Large grained Granite
Fine grained Granite
Section on the line e f
Large grained Granite
Fine grained Granite
Section on the line g h
North
Plan
Vein of Granite
Vein of Short
Vein of Short
Vein of Granite
Vein of Short
Large grained Granite
Vein of fine grained Granite
Granite
View of the northern wall of the Cove

THE

PHILOSOPHICAL MAGAZINE

AND

ANNALS OF PHILOSOPHY.

[NEW SERIES.]

APRIL 1829.

XXXVII. *On the Junction of the Granite and the Killas Rocks in Cornwall.* By Messrs. Von Oeynhausen and Von Dechen.

[With a Plate.]

[Concluded from p. 170.]

VIII. *Carclaze Tin Mine near St. Austle.*

CARCLAZE tin mine is situated about two miles on the north of St. Austle, in the granite, and very near to the junction of this rock and the killas (figs. 21 & 22). The junction is nearly perpendicular, but dipping to the south; the killas is decomposed into an earthy and argillaceous mass; but the stratification is nevertheless distinct, the strata underlie rapidly to the south; therefore the killas is in a position unconformable to the granite. The mine forms a large excavation, open to the day, and is said to be 250 fathoms in length, one hundred fathoms in breadth, and twenty-one or twenty-two fathoms in depth. The direction of the greatest length of this remarkable opening is 30 degrees north of west. In the eastern part of the excavation are several shafts sunk below the bottom of it, by which tin ore is raised to the depth of ten fathoms under the adit. The granite is here of a light yellowish white colour, and extremely decomposed; the felspar is changed into a white China-clay, and shows the contours of crystals of the common size; schorl occurs very frequently here. This granite differs from that kind which commonly prevails; the twin crystals do not occur in it; but it is very nearly the same as at Cligga Point. The common kind of granite is found of great extent in the neighbourhood, and used as building stone under the denomination of Moorstone.

The granite at Carclaze is intersected by numberless veins

and strings which contain tin ore, and in the neighbourhood of which the granite also contains tin ore. These veins consist chiefly of quartz and schorl, and have the strongest resemblance to those which occur at Cligga Point; even their influence on the rock through which they pass, is the same. The walls of these veins at Carclaze are very hard, quartzose, of a grayish hue, and not at all decomposed. These tin lodes run in every direction through the granite, but they are more prevalent in one direction than in any other, that is in a direction 22 degrees north of west; their underlie is towards south, the angle they form with the horizon being 35 degrees. The distances between these veins being very short, they give to the rock a stratified appearance. Other tin lodes run between 15 and 30 degrees east of north; they intersect the former tin lodes without heaving them, and also without being heaved by them: it is said that very rich tin ores are found where these different lodes intersect one another. These veins present frequently in the interior an open string, or white quartz, with tin ore and wolfram; the walls are changed to a width of a few inches only, so that their whole breadth does not exceed from two to six inches; it is seldom twelve inches. Besides these tin lodes, white quartz veins occur here running between 15 and 30 degrees west of north, being nearly perpendicular; the quartz is crystallized from the walls to the interior of the veins; the breadth of these veins is from one to two inches; they do not contain any metallic substance, and heave every tin lode they meet with in their course.

The granite in the southern wall of the excavation contains a large portion of schorl at a depth of thirty or fifty feet under grass; the quartz prevails more in these places than the felspar, and the rock has not undergone so perfect a decomposition as in other parts; this rock forms a transition to the schorl rock, and is unquestionably the same rock that occurs before you reach Cligga Point. The schorl occurs frequently in granite, surrounding the opening of the mine near to the surface. A tin lode called the black lode has been very productive in the parts where it crosses the granite, containing a large portion of schorl. The lodes contain only tin ore and wolfram; no copper or iron ore is found in them. This may be considered also to be the principal reason why the tin ore in the stream-work does not contain copper, taking its origin mostly from granite countries. China-clay is raised on the north of Carclaze, about one mile distant. The soil is covered there by little quartz pyramids, as well as near Cligga Point, and near St. Agnes' Beacon. The clay-pits are in a highly decomposed

composed granite, in which numberless double six-sided quartz pyramids are imbedded: the contours of the crystals of felspar may be seen very easily in the greater part of this granite; it must therefore be a granite decomposed *in situ*, and not deposited as an alluvium. The China-stone which is raised on the western side of Tregonning Hill near Helston, is a granite in which the decomposition has proceeded no further than to render the whole mass friable; only one part of the felspar is changed into clay.

IX. *St. Michael's Mount.*—St. Michael's Mount is a small island nearly three hundred feet high, situated in the bay, at a distance of about three miles from Penzance; the greater part of it consists of granite; the killas appears only on the northern side of the island, and is greenstone where it comes in contact with the granite. The strata of the killas as well as the junction between both rocks dip to the north-east at an angle of 20 degrees at the eastern side of the island; on the northern side the strata dip in the same direction at an angle of 45 degrees; on the western, they underlie very rapidly to the north; but the junction of both rocks is not parallel to the strata of the killas here, being nearly perpendicular. Granite veins run in every direction through the killas in the neighbourhood of the junction between both rocks; they start evidently from the main body of the granite; they do not present any other fact than those veins hitherto described. Quartz veins occur very frequently in the killas; they both intersect the granite veins, and are intersected by them. Other quartz veins, of which the mass is that kind called milk quartz, are more regular; they are from an inch to an inch and a half wide, and therefore they may belong to a different formation from those first mentioned. Quartz veins containing mica also occur, and perhaps they may belong to those veins of quartz, the description of which shall soon follow; but several of them may be said to belong rather to the granite veins. Veins of mica, the crystals of which shoot out from the wall to the interior, occur in the killas as well as in the granite; they contain a small portion of quartz, and run generally nearly east and west. The main body of the granite forming this hill is of a very light colour, containing much felspar, but no twin crystals porphyritically dispersed through the mass; therefore it has some resemblance to the granite of Carclaze, Cligga Point, and Tregonning Hill. But it partakes of the nature of the granite at the two points first mentioned, still more than by this appearance, by being intersected by numberless quartz veins, running nearly east and west, dipping nearly perpendicularly, containing fine crystals of oxide of tin, wolfram, mica, apatite and topaz; their walls consist of a

granite differing from the rest by containing more quartz and being harder; these quartz veins therefore evidently appear to be of the same kind as those of Cligga Point and Carclaze.

X. *Tol Pedn Penwith. Cape Barrah.*—Hitherto we have given the description of granite veins in the killas and in the serpentine, but these veins also occur in the granite itself; Mr. Carne mentions them, page 53, *loc. cit.* The most south-western promontory of the Land's End district, Tol Pedn Penwith and Cape Barrah, appears to exhibit the most extraordinary facts. The granite in the neighbourhood is that of the common kind, with porphyritic twin crystals of felspar, with schorl and pinite, as may be seen going down from the small village of Sawah to the cliffs. There, at the point (*i*) fig. 23. appears fine-grained granite, quartz and felspar, of a very close texture; the latter being of a red colour, gives to the whole rock a reddish hue; mica is not abundant in it, but schorl is more common. This granite is of the same kind as that which forms the veins; but here its position is not that of a vein. It appears in the cliffs for a considerable distance below the large-grained granite; the section, fig. 26. represents its position; the junction of both is very distinct, and dips to the east at an angle of 10 degrees. In some places both rocks hang together; but an open interstice is left between them, broad enough to admit the blade of a knife. Some large crystals of felspar occur near to the junction in the fine-grained variety, but are not found further off from this line than three or four inches. A sort of terrace traces this junction along the cliffs; in the section (*c d*) fig. 25, the overlying large-grained granite projects over the fine-grained, like the roof of a house; the inclination of the junction is here 30 degrees. To the north the junction of both the rocks inclines to the sea, and in the cove (*l*) fig. 23. the elevation of the fine-grained granite above the level of the sea is not very considerable; the point where the large-grained granite comes down to the sea was not accessible. On the other side the fine-grained granite may be traced as far as the cove (*m*); the junction of both sorts of granite becomes steeper and steeper, and suddenly the underlying mass of fine-grained granite is stopped by numberless little quartz veins, which, for the breadth of thirty feet, intersect the rock. The fine-grained granite may reach at the highest points the height of 150 or 200 feet; and continues here as far as the level of the sea; it is intersected by a great many quartz strings, which bear a striking resemblance to those at Cligga Point. The mass of fine-grained granite is perfectly fine-grained, from the junction with the large-grained to the distance

of

of twenty feet; but further off, the constituent parts, the quartz as well as the felspar, become larger and larger, and porphyritic twin crystals of felspar begin to appear here and there; so this rock gradually passes into the character of the large-grained granite, from which it is so evidently different at the junction of both. As far as the steepness of the cliffs allows access to the mass of underlying granite, it does not yet assume the same appearance as the overlying large-grained granite; but it cannot be very doubtful that near the level of the sea a granite not different from that at the top of the cliffs would be found, if access to it could be in any point obtained. The component parts in both sorts of granite being quite the same, they only differ one from the other by their texture and different state of crystallization.

A vein of fine-grained granite occurs in the main body of the large-grained granite near (*n*) fig. 27; it may be traced for a considerable length in its direction; it appears to start from the main body of fine-grained granite, this being not very far distant, and its mass bearing a near resemblance to it. This vein is partly separated from the granite forming its walls by an open interstice in which schorl frequently occurs. Between the lines of section (*e f*) and (*g h*) occur several veins of fine-grained granite coming out of the main body of granite of the same nature;—a vein of this kind is represented in the section, fig. 24.

Several granite veins occur on both walls of the cove (*o*): one, being a foot wide, represented fig. 28. is undoubtedly the same which appears near the point (*n*); it runs 15 degrees west of north, and is nearly perpendicular. Another vein underlies rapidly, is ten inches wide, and heaved by two strings of quartz. The granite in these veins is fine-grained, and exactly of the same description as that of the main body of fine-grained granite; the contents of the vein are very distinctly separated from the large-grained granite forming the walls of the veins. On the other wall of the cove (*o*), fig. 29. may be traced chiefly the last-mentioned granite vein; this separation from the walls is so perfect, that large hollows are found on it by the action of the sea; the length for which the vein is exposed to sight may be more than two hundred feet; at last it joins another granite vein, which is thirteen feet wide and nearly perpendicular. On both walls the granite in this large vein is very fine-grained, but in the interior it becomes of a larger size as to its constituent parts, and here it contains more green mica and black schorl. Small strings go off from this vein, which is intersected by open strings as well as the granite forming its walls. The promontory called Tol Pedn Penwith

Penwith consists only of the common sort of porphyritic granite; in the eastern cove occurs a vein of fine-grained granite. In a little cove on the west of the signal placed on the promontory is a quartz vein one foot wide, running north-west and south-east, and dipping to south-west at an angle of 66 degrees; a little gossan joins it, and it *seems evident that this quartz vein belongs to what the Cornish miner calls a lode.* This quartz intersects a granite vein (fig. 30.) of the breadth of three or four inches, and heaves it nearly two feet: the same granite vein is intersected by a schorl vein without being heaved; and this schorl vein also is intersected and heaved by the quartz vein. The granite vein continues to a very considerable extent into the sea; it is here divided into two branches; the large twin crystals of felspar they meet with, are intersected by them, and heaved about half an inch. This granite vein contains only a small portion of mica, but in some places much schorl, and takes the appearance of a schorl vein. The schorl vein has had influence on the granite in its walls, where the felspar is found to be changed into China clay.

The killas overlies the granite; and the granite must have formed a basis on which the killas could be deposited; therefore granite may be considered as the oldest rock in this country. Other masses of granite, from which the granite veins in the killas and the granite itself strike off, appear to have been introduced at a more recent period in the granite first mentioned, and evidently after the formation of the killas in which the granite veins are found. Masses of granite of this kind may occur very frequently; and perhaps the granite of St. Michael's Mount, of Cligga Point, of Carclaze, and of Tregonning Hill, may belong to that granite afterwards introduced into the solid of the rock: but to prove it would be very difficult; because the position of these granite masses is not so well laid open to the view as at Tol Pedn Penwith. It will appear evident that at the junction of both kinds of granite only is it possible to distinguish them; the interior of both being formed in such a manner that they cannot be distinguished. The granite veins, the schorl veins, and the tin lodes in the granite, appear to belong to the oldest formation of veins which has taken place in these countries. The copper lodes, and those tin lodes which occur in the killas, and commonly contain some copper ore, belong to a later formation, and we should think both belong to the same formation.

The killas is, at its contact with the granite, rather hornblende-slate and greenstone than clay-slate; in the Lizard district we have seen the greenstone intimately mixed with granite, both occurring even in the same vein. The transition from

from clay-slate into hornblende-slate and greenstone is commonly so gradual, that we have not been able to trace anywhere a line of junction between both rocks. This transition from clay-slate into the greenstone is not always formed from one stratum to the other; but the stratification is disturbed in these places by numberless fissures; and there are found masses of greenstone of every imaginable contour, mingled with the clay-slate. The iron (*ire*) stone in the neighbourhood of Redruth and Camborne, which is found at the surface in several places, and also is well known to the miner by its extreme hardness, appears to be nothing else than this kind of greenstone imbedded in the killas. It is worthy of remark, that this ire-stone occurs here not very far from the junction of the granite and killas laid open to view in the deep mines of Dolcoath and Cook's Kitchen, and that the line in which it is found differs not much in its direction from that of the above-mentioned line of junction between the granite and killas. We may venture to say that this ire-stone has not here the appearance of a regular course or vein in the clay-slate, as far as our observations reach on this subject. In the killas surrounding the granite of Dartmoor in Devonshire, near Tavistock, also greenstone frequently occurs; it is of a very schistose kind, so that one may be induced to consider it as clay-slate altered by some subsequent power.

It would perhaps be too bold to say that all the elvan courses which frequently occur in Cornwall belong to the granite veins, and were going out from underlying masses of granite; but we cannot forbear to remark, that some of them partake very much of the appearance of the fine-grained granite commonly filling the granite veins, and in some places more than of a porphyritic appearance; that rocks of a porphyritic kind are intimately connected with the granite, as at Cligga Point; that these elvan courses certainly belong to the oldest formation of veins in the country, and therefore that they do not differ in this respect from the granite veins.

Swansea, Jan. 14, 1827. V. Oeynhausen. V. Dechen.

XXXVIII. *Experiments and Observations on some of the Phænomena attending the sudden Expansion of compressed elastic Fluids.* *By* Peter Ewart, *Esq.**

HAVING occasion, about seven years ago, to make some experiments on a high-pressure steam-engine of the estimated power of nine horses, in the boiler of which the elas-

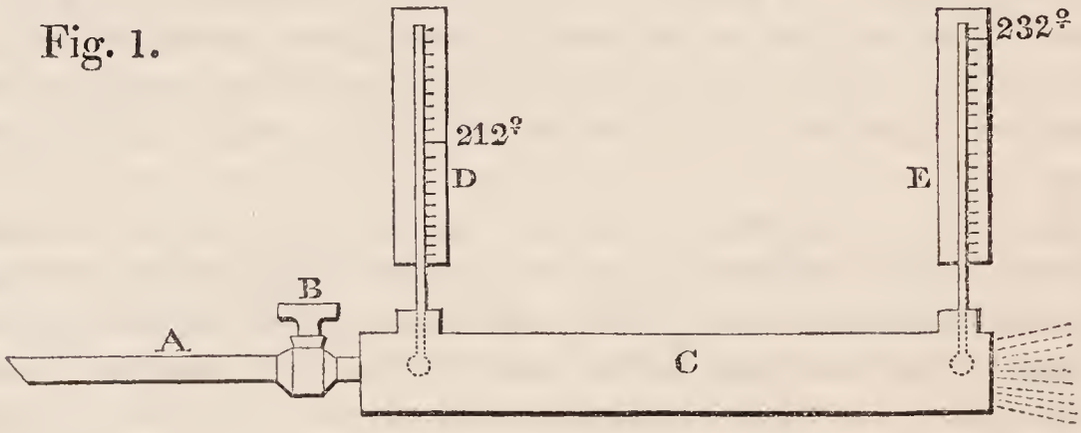
* This article consists of extracts from two papers read before the Literary and Philosophical Society of Manchester;—communicated by the Author.

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ticity of the steam was equal to sixty pounds (including the atmosphere) on the square inch, and, consequently, the interior temperature about 290° of Fahrenheit, I applied the bulb of a thermometer close to the opening of the safety-valve, while the steam issued from it in great quantity, and it stood steadily at 160°. The engine being in motion, and the steam, after having passed through the cylinder, escaping to the atmosphere by a perpendicular pipe four inches diameter, and five feet in height, I applied a thermometer to the steam as it issued from the top of that pipe, and found the temperature to be 212°.

Finding the temperature of the issuing steam only 160° at the safety-valve, close to the boiler, and 212° after it had passed to the distance of five feet from the boiler, I constructed an apparatus (fig. 1.) for the purpose of ascertaining whether, under certain circumstances, the temperature of the steam increases after it has issued from the boiler. I had an opportunity (in March 1823) of applying this apparatus to the high-pressure steam-boiler of Mr. Philip Taylor, at Bromley, near London. A is an iron pipe of three quarters of an inch bore,

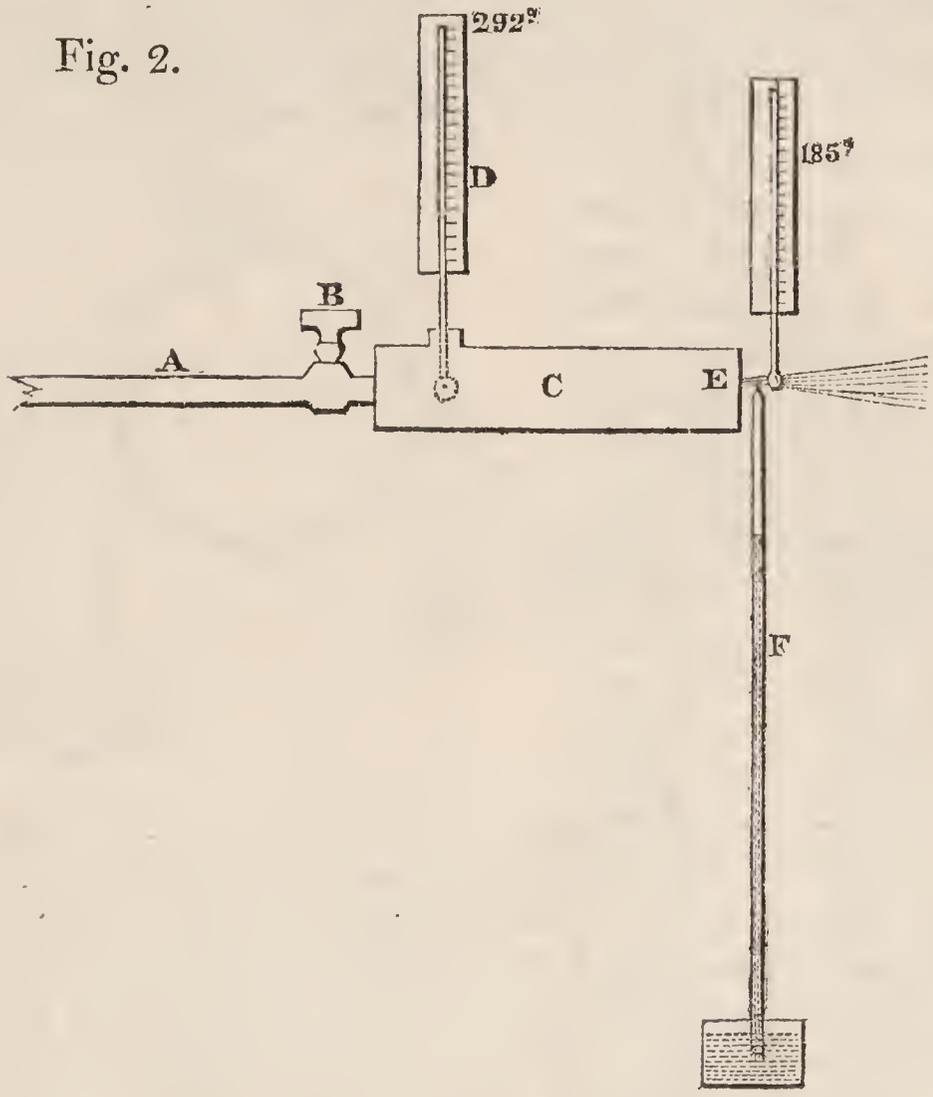
Fig. 1.



connected with the boiler, and terminated by a stop-cock B, the area of the opening of which was the same as that of the pipe. The end of a copper tube C, two inches diameter and sixteen inches long, was screwed to the cock B, so as to be steam-tight. To this tube was adapted a thermometer D, so that the bulb stood directly opposite the centre of the opening of the cock B, and at the distance of an inch and a half from it. The opening in the side of the copper tube, through which the stem of the thermometer passed, was made steam-tight. Another thermometer E was fixed in the same manner, near the extreme end of the copper tube, which end was quite open to the atmosphere. The elasticity of the steam in the boiler being equal to fifty-eight pounds, including the atmosphere, on the square inch (the internal temperature consequently about 285°), and the cock B fully open, the thermometer D stood at 212°; while E stood at 232°, showing an increase

increase of 20° of temperature at that end of the copper pipe. The tube being removed, another copper tube C (fig. 2.) of

Fig. 2.

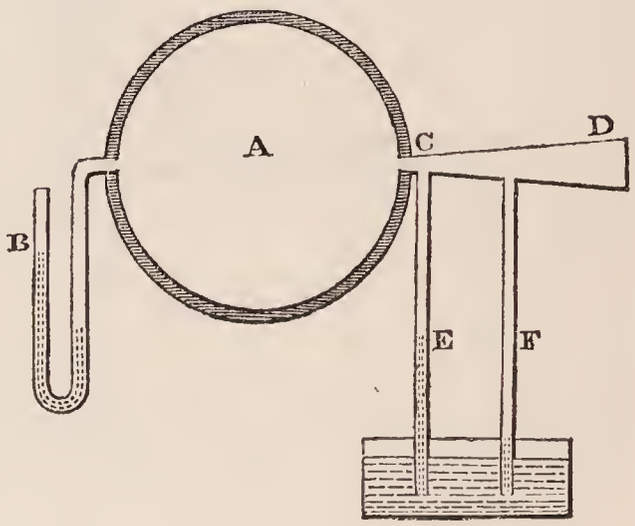


the same diameter, and nine inches long, was screwed to the same cock B. This tube was furnished with a thermometer D as in the last experiment. The end E of the copper tube was stopped by a flat plate, excepting a hole 1-12th of an inch diameter, in the centre of the plate. The steam in the boiler being about the same force as in the last experiment, and the cock B being opened, the thermometer D stood at 292°; while another thermometer, having a very small bulb, held near the hole at E, as the steam issued from it, stood at 185°. A small glass tube F, open at both ends and drawn to a fine point at the top, was placed so that the top of the tube was in the jet of steam issuing from E, while the lower end of it was immersed in a trough of mercury. The thermometer D standing at 292°, as before, the mercury rose twelve inches in the tube F. The mercury stood highest in F when it was near to E.

In August 1825, I had an opportunity of making some experiments on the sudden expansion of atmospheric air at Messrs. Fairburn and Lillie's foundry in this town, of which the fol-

lowing was one. A (fig. 3.) represents a transverse section of a cylindrical horizontal pipe, seven inches in diameter, which conducts air from a blowing apparatus to a furnace. B is an inverted glass syphon inserted into the side of the pipe A. A round hole, 4-10ths of an inch diameter, was made in the opposite side of the pipe, to which was adapted a conical tube of tinned iron CD, 5·4 inches long, and whose internal diameter was ·4 inch at C, and 1·05 inch at the extreme end D, which was open to the atmosphere. To the lower side of this conical tube, two perpendicular glass tubes, E and F, were attached, their upper ends opening into CD, and their lower ends being immersed in a trough of mercury. The centre of the tube E was ·5 inch from the inside of the pipe A, and the centre of F was 2·2 inches from the centre of E. Some mercury having been put into the inverted syphon, and the blowing apparatus being set to work (the air passing through A at the velocity of forty-five feet per second), the mercury stood at 1·8 inch higher in the outer than in the inner leg of the syphon; while the mercury in the trough rose 2·7 inches in the tube E, and only ·4 inch in F; showing a greatly diminished pressure in the air at E, while its pressure was much increased in passing from E to F. On the internal pressure in A being increased, the mercury rose higher in nearly the same proportion in E and F.

Fig. 3.



In the *Annales de Chimie et de Physique* for September 1827, there is an account of a fact observed in 1826 by Mr. Griffith, engineer, at Fourchambaut, which is described as consisting of this:—That if air strongly compressed in a reservoir escape by an orifice in a plane surface, and if a plate or disk of metal be presented to the jet of air, that plate is attracted to, instead of being repelled from, the flat surface from which the air issues *.

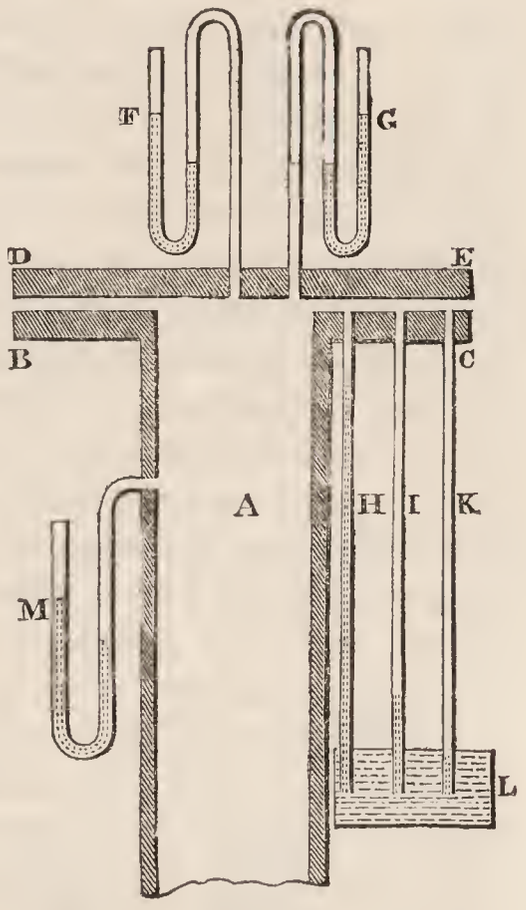
In the same article in the *Annales de Chimie*, there is an account of some experiments and their results on the issuing of compressed steam.

* This fact had been previously observed in October 1824, by Mr. Roberts, a member of the Manchester Philosophical Society.

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Some of these results agreeing, and some being at variance, with those exhibited in figs. 2. & 3, I constructed the following apparatus for the purpose of examining more distinctly the effects produced by the expansion of compressed air under similar circumstances. A (fig. 4.) is a longitudinal section of a perpendicular pipe of four inches internal diameter, connected with a reservoir of compressed atmospheric air. BC is a cross section of a flat circular piece of wood 11·8 inches in diameter, having a circular orifice four inches diameter through its centre, and adapted to the upper end of A, so that this orifice shall coincide with the interior circumference of A. DE is the section of another flat circular piece of wood, of the same diameter as BC, and placed directly over it, and fixed so that it may be uniformly depressed or raised from BC by means of screws.

Fig. 4.



F is an inverted glass syphon inserted into the centre of DE, and G is a similar syphon inserted into DE, at the distance of 1·5 inch from F. H, I, and K are three small glass tubes, open at both ends, inserted into BC, and having their lower ends immersed in a trough L of coloured water. The centre of the tube H was at the distance of ·9 inch; that of I, 2·1, and that of K, 3·4 inches from the interior side of A. The space between BC and DE being adjusted to ·2 of an inch, some mercury being put into all the inverted syphons, and the compressing apparatus being set to work,—the syphons G and M indicated each an interior pressure of 1·25 inch, and the syphon F, 1·3 inch of mercury. The coloured water rose 9· inches in H, 2· inches in I, and ·5 inch in K. On the interior pressure in A being increased, the coloured water rose higher, in nearly the same proportion, in H, I, and K; and the amount of the downward pressure on DE still much exceeded that of the upward pressure from A.

Some of these results being still at variance with some of those described in the article of the *Annales de Chimie* already quoted, I prevailed on Mr. Dalton to witness a repetition of

the experiments (fig. 4.), in November 1828, and he was satisfied that the results were correctly stated.

Various explanations have been proposed of some of the phænomena which I have described.

It has been supposed, that the ascent of the mercury in figs. 2. & 3, and of the coloured water in fig. 4, is occasioned, not by the rarefaction of the fluid in contact with the upper ends of these tubes, but by the particles of fluid in the tubes (whether these particles be of air, water, or mercury) being drawn or sucked out by some kind of lateral action of the issuing fluid. But if there were any action of that kind, its effects would have been apparent in the inverted syphon (fig. 3.); and the mercury in the leg next to A (in which the air was moving at the rate of forty-five feet per second) would have been elevated instead of being depressed.

I applied an inverted syphon to the air-reservoir of a similar blowing apparatus, in which the interior pressure was equal to 33·5 inches of mercury (including the atmosphere), while another syphon was applied to the conducting pipe, as in fig. 3, at the distance of twelve feet from the reservoir. The air was passing along the pipe with the velocity of forty-eight feet per second, and the interior pressure was only 1-268th part less in the conducting-pipe than in the reservoir.

Explanations of the low temperature of high-pressure steam, at the place where it issues, have indeed been proposed, without any reference to the rarefaction of the steam at that place. It has been held by some, that the steam issues with so great a velocity at that place, that it has not time to give out its heat; that unless part of the steam be condensed into water, little or none of its heat can be given out; and it has been asserted that when the hand is presented to such steam, it remains dry. Others have held, that the current of steam carries with it a current of air, attracted in some manner to its sides, by which the bulb of the thermometer is cooled.—My hand, however, has always been wet by the steam when presented to it; and in most of the experiments which I have made, the bulb of the thermometer was surrounded with steam; so that it could not be affected by any external air supposed to adhere to the sides of the current of steam.

That the temperature of high-pressure steam, on being released, should come down to the temperature of steam of atmospheric pressure, is what might be expected. But how it instantly falls so much below 212° requires some explanation.

There are three circumstances to be observed in the foregoing experiments, which appear to require particular attention.

1st, The reduced pressure takes place in the greatest de-

gree

gree near the point where the air or the steam is released from compression. (See figs. 2. 3. & 4.)

2ndly, After the air has been suddenly expanded, it quickly recovers a large portion of its former density. (See figs. 3. & 4.)

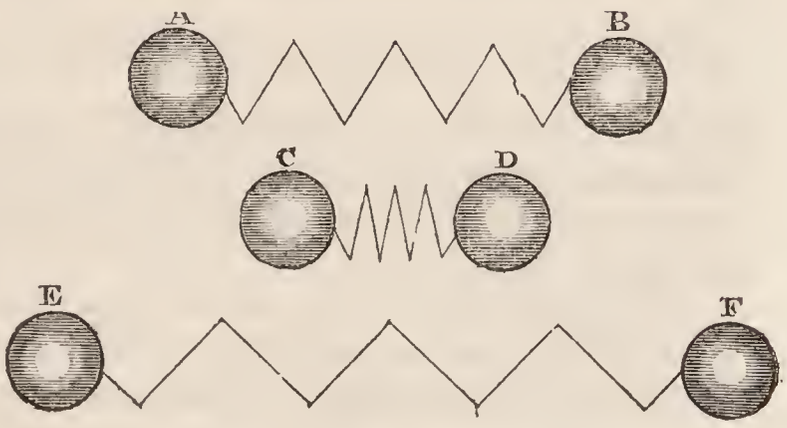
3rdly, A portion of elastic fluid of a given density is displaced by another portion of the same fluid, of much less density than that of the fluid which has been displaced. (See figs. 3. & 4.)

In October 1822, I read a paper before this Society, giving an account of some experiments which I had then made on this subject, and suggesting an explanation of the results on mechanical principles. I did not offer it then, nor do I offer it now, with the expectation that it will be generally considered as satisfactory. All the experiments, however, which I have made since that time, admit, as it appears to me, of that explanation; and I have had the satisfaction to find that it has been adopted by some very good experimenters.

Such as it is, I beg leave to offer it again, after an interval of six years, to the consideration of this Society.

If we suppose A and B (fig. 5.) to be two equal balls of lead attached to the opposite ends of an elastic spring; and if we suppose the spring, in the position of A and B, to be in a neutral state, that is, to have no tendency either to expand or collapse.

Fig. 5.



If we next suppose the balls to be compressed together as at C and D, and then suddenly set at liberty, they will, by the joint action of elasticity and momentum, spring out, not only to the distance they were at originally as at A and B, but to a distance as at E and F, as much beyond their original distance as they had been compressed within it. After having been separated to that distance, they will collapse and vibrate to and fro for a time.

Now if elastic fluids, such as air and steam, consist of separate particles, we know that these particles are kept asunder by an elastic force, the same in effect as if steel springs were interposed between them; and we cannot doubt that such particles have momentum like all other ponderable matter; neither can I see any reason to doubt that the sudden

expansion

expansion and contraction of their distances must be similar to those of the leaden balls.

Thus, if we suppose A and B to be two particles of atmospheric air, at the distance they are in the atmosphere; if they be compressed as at C and D, and suddenly released, they will be separated as at E and F, and produce all the effects of a corresponding rarefaction or dilatation. It is true they may not separate so far as at E and F, because of the interruption they meet with from other particles of air in the atmosphere; but it is reasonable to conclude that they will separate beyond the distance of A and B. After being separated to their greatest distance, they will collapse, not by the reaction of the elastic force between them, as in the case of the leaden balls, but the similar action of the elastic force of the particles of air into which they are projected.

In this view of the phænomena, by the combined mechanical action of elasticity and momentum, the low pressure of highly compressed steam, at the place where it is released, becomes only what is due to its mechanical dilatation,—the consequence of its previous compression. And, accordingly, it is found that the more it is compressed, the more dilated and the colder it is when suddenly released.

XXXIX. *Remarks on* Mr. Phillips's *Essay on Manganese:—in a Letter to the Author. By* Edward Turner, *M.D. F.R.S.E. &c. Professor of Chemistry in the University of London**.

My dear Sir,

HAVING the misfortune to differ from you respecting several of the remarks contained in your Essay† on a new ore of manganese, and feeling that the temperate discussion of scientific subjects rarely fails to advance the interests of science, I do not hesitate to offer the following comment on your opinions. As you now admit the accuracy of my view relative to the formation of the protosulphate by the action of sulphuric acid on the peroxide of manganese, I need not particularly advert to that subject; but will confine my remarks to two parts of your Essay: namely, to your description of the Warwickshire manganese, and to your observations on my analysis of manganite.

I. I cannot admit the correctness of your views on the composition of the Warwickshire manganese; and the opinion

* Communicated by the Author.

† Last Number of this Journal, page 209.

which

which I expressed to you by letter before the publication of your Essay, as the result of a partial and hasty examination, I am now, after careful experiment, prepared to maintain. I have of course employed in these researches the specimen which you were so kind as to give me; and as it is quite free from foreign matter, except a little silica and copper as you mention, I apprehend there can be no doubt of our having operated with the same mineral in its state of greatest purity.

Before proceeding to the analysis, I may remark, that part of your mineralogical description is inexact. You state, for instance, that the colour of the Warwickshire manganese is gray, not materially differing from the tint of the well-known crystallized peroxide; that it is much harder than that mineral, does not soil the fingers so much, and is lighter in the proportion of 4·283 to 4·819. If my recollection serves me, most of these statements were derived from my own letter; and though in reference to part of the Warwickshire manganese they are very near the truth, they are erroneous as applied by you to the whole mineral. The Warwickshire ore, I conceive, is not, as you imagine, a new definite compound of oxygen and manganese, but a mixture of two well-known oxides, manganite or the hydrated deutoxide, and pyrolusite or the anhydrous peroxide. These oxides are so intimately blended with each other in the Warwickshire manganese, that it is difficult to obtain either in a state of purity. I have succeeded in collecting very pure fragments of manganite; and though no crystalline figure is discernible, all the other characters agree exactly with those of pure manganite from Ihlefeld. The cleavage, lustre, hardness, and colour of the powder correspond closely, or I may even say exactly: and the specific gravity of the purest and most compact fragments which I have obtained, is 4·336; while that of a perfectly pure crystal of manganite, taken at the same time, is 4·319. The results of analysis likewise coincide, as the following numbers will show:

	Manganite from the Warwick Ore.	Manganite from Ihlefeld.
Red oxide.....	86·55	86·85
Oxygen	3·23	3·05
Water	10·12	10·10
	100·00	100·00

The peroxide in the Warwick ore is so intimately mixed with manganite, that I have been unable to effect a perfect separation. That manganite thus pervades the substance of the ore is obvious to the eye, since laminæ of that mineral may be seen in almost every part; and the presence of two distinct compounds

compounds is likewise indicated during the act of pulverizing the mineral, some portions yielding readily to pressure, and others giving considerable resistance. Manganite and the peroxide are not mixed in any uniform proportion. The harder, compact, laminated parts consist chiefly of manganite; and the peroxide prevails in those portions which are made up of small crystalline grains, so loosely cohering that they crumble down under the pressure of the fingers. These portions are very soft, and yield a black powder almost as dark as pure peroxide, and which like it is disposed, when touched, to soil the fingers. Their specific gravity is 4·844; whereas the specific gravity of pure peroxide varies, according to my observation, from 4·819 to 4·94.

The analysis of the Warwick ore confirms this view. The ore indiscriminately reduced to powder, and exposed to a white heat, loses, as you state, about 13·26 per cent, 5·4 parts of which are water. The powder which collects when the ore is broken into small fragments with a hammer, lost in a white heat 13·13 per cent, only 4·97 of which were water. The water in the softest portions above described amounted to only 2·97 per cent.

These observations, admitting their accuracy, fully justify the conviction expressed at the commencement of this letter, that the Warwickshire ore is not a definite compound of manganese and oxygen, but a mixture, variable in different parts, of manganite and peroxide. That you will find the remarks accurate I do not entertain the least doubt; for I would not venture, without being very sure of my facts, to differ from so experienced and expert a chemist.

In order to facilitate your inquiry, I send several fragments of the Warwick ore, some of which are nearly pure manganite, others are soft and consist chiefly of the peroxide, and in others both oxides occur together. For the sake of comparison I also send some fragments of crystals of the Ihlefeld manganite.

It is worthy of remark, that in the Warwickshire manganese the manganite abounds most in the outer portions, while the peroxide is most abundant in the interior. There is no appearance, therefore, of the ore having been originally manganite, and subsequently converted, in part, into peroxide by a process of disintegration. To justify that supposition, the relative position of the two oxides ought to be precisely the reverse.

II. I now proceed to show that the doubt which you express concerning the accuracy of my analysis of manganite, is without foundation. You appear to imagine that the quantity of water reported in my analyses, was inferred from the loss which

which the ores experienced by exposure to a red heat, and that I was ignorant of the well-known fact, that some of these oxides lose oxygen as well as water at that temperature. You must have overlooked a portion of my Essay altogether, otherwise you would not have made the supposition. By referring to the commencement of the second part of that Essay, you will find that the water was in every instance ascertained by heating a known quantity of the ore to redness, and collecting the aqueous vapour in a tube filled with fragments of the chloride of calcium. This method is at least as accurate as that adopted by yourself, and gives results of great uniformity. The specimen of Ihlefeld manganite which accompanies this letter, will enable you to correct me if I am in error. Of course the same doubt, as applied to the analysis of psilomelane and the *manganèse oxidé baritifère*, is equally inappropriate. The difficulty of discovering the atomic nature of these compounds arises, as I have mentioned in my Essay, from their impurity. The latter is visibly interspersed with particles of the peroxide; and the former, from its analogy to the other, and from the intimate manner in which it is associated in nature with the peroxide, is, I believe, equally impure.

Some of your remarks on the formation of what is called the red sulphate of manganese, appear to me perfectly correct: I shall waive, however, any further comment on this compound at present, and will probably make it the subject of a future communication.

I remain, my dear Sir, very truly yours,

University of London, March 5, 1829. EDWARD TURNER.

XL. *Determination of the Latitude and Longitude of the Observatory on the Calton Hill. By* WILLIAM GALBRAITH, *Esq. A.M.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

Edinburgh, July 14, 1827.

IT appears to me that the problem originally proposed by Richard Townley, Esq. and resolved by Mr. John Collins, in the Philosophical Transactions, No. 69, and has since been repeatedly given in various publications, might be advantageously extended to more generally useful purposes than it has been hitherto.

As I had occasion to give a small table of the latitudes and longitudes of places, I was desirous of inserting that of the

new Observatory on the Calton Hill here; and being unprovided with any very good instruments which could be relied on with a tolerable degree of confidence, I thought if it were possible by any means to connect it with the Trigonometrical Survey, my purpose would be accomplished. It is obvious, by observing intersections from a few points or stations in the Survey, well ascertained, my object would be more accurately performed. But this would have required time, expense, considerable trouble, and good instruments. It occurred to me, therefore, that an extension of the problem above noticed, were the stations judiciously chosen, so as to avoid the indeterminate case, would answer the objects I had in view. Thus, conceiving the arcs between the stations visible from each other on the surface of the earth to be straight lines, from which in moderate distances they do not much differ; or if great nicety be required, let them be reduced to such by the usual methods, and supposing meridians to pass through these points, and also the place of observation,—then by the principles of spherical trigonometry, the distances of these three points may be computed, and consequently by the problem of Townley, also the distances of the same points from the place of observation. Now by spherical trigonometry the co-latitude and difference of longitude of the place of observation from all of the three given positions, of which the latitudes and longitudes are known, may be found by computation. The results, however, would be rather more accurate, were a correction for the spheroidal figure of the earth applied to the latitudes, though the difference, even near 45° where it is greatest, only amounts to a very few seconds. In this case, unless very great precision be required, the correction may be neglected.

I shall illustrate this method of proceeding, which may be useful where a proper opportunity accompanied with the necessary advantages for a superior cannot be obtained.

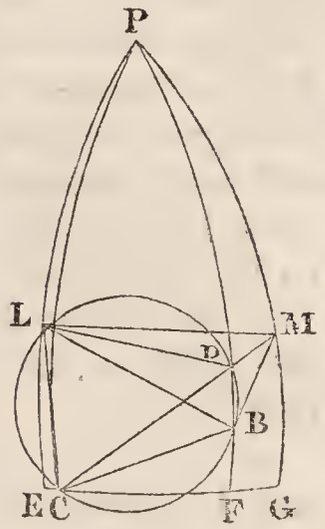
It may be remarked, however, that many of the poles put up by the trigonometrical surveyors have been wantonly destroyed; so that without the trouble of replacing them, very correct intersections cannot, as was the case in the present instance, be obtained.

The observations were made with a repeating theodolite placed near the old entrance from the east, into the grounds surrounding the Observatory.

The angle between North Berwick Law, in latitude 56° 3′ 8″ N., longitude 2° 42′ 11″ W., and the Isle of May Light, in latitude 56° 11′ 22″ N., longitude 2° 32′ 47″ W., was 13° 48′ 48″; and the angle between the Isle of May and the West

West Lomond, in latitude 56° 14′ 57″ N., longitude 3° 17′ 4″ W., was 68° 40′ 46″: what is the latitude and longitude of the Observatory?

Let P be the north pole, C the Calton Hill, L the West Lomond, M the Isle of May Light, and B North Berwick Law; also ECFG a parallel of latitude passing through C, and PE, PC, PF, and PG, meridians passing through L, C, B, and M.



Then by the problem originally proposed by Townley, let the marginal figure be constructed, and apply the principles of spherical trigonometry; since the lines employed are arcs on the surface of the earth, which in this case may be considered as a sphere.

Now by the Trigonometrical Survey we have,—

West Lomond, latitude...	56°	14′	57″	N. long.	3°	17′	4″	W.
Isle of May Light.....	56	11	22	——	2	32	47	
North Berwick Law.....	56	3	8	——	2	42	11	

Whence are obtained PL = 33° 45′ 3″ LPB = 34 53
PB = 33 56 52 LPM = 44 17
PM = 33 48 38 BPM = 9 24

1. In the triangle LPB, there are given the sides PL, PB, and the angle LPB, to find LB = 22′ 44″·48 = 26·17 English miles.

2. In the triangle LPM are given PL, PM, and the angle LPM, to find LM = 24′ 52″·88 = 28·632 English miles.

3. In the triangle BPM are given PB, PM, and the angle BPM, to find BM = 9′ 45″·56 = 11·23 English miles.

4. In the triangle PLB are given all the sides to find the angles PLB and PBL = 121° 3′ 52″, and 58° 27′ 10″ respectively.

5. In the triangle LBM are given all the sides now found by computation to determine the angles LBM = 90° 51′ 40″; and BML = 66° 2′ 54″. Also LBM − LBD = 90° 51′ 40″ − 68° 40′ 46″ = DBM = 22° 10′ 54″; and 180° − (BLD + LBD) = 180° − 82° 29′ 34″ = 97° 30′ 26″ = LBD. BLM will also be found to be 23° 5′ 28″; whence BLM − DLB = 23° 5′ 28″ − 13° 48′ 48″ = 9° 16′ 40″.

Likewise LD will be found = 21′ 22″·08, LDM = 128° 28′ 28″, LMD = LMC = 42° 14′ 52″. But LMC + LCM = 110° 55′ 38″, and consequently CLM = 69° 4′ 22″; CLM − BLM = 69° 4′ 22″

$-23^\circ\ 5'\ 28'' = 45^\circ\ 58'\ 54'' = \mathrm{BLC}$. But $\mathrm{BLC}+\mathrm{PLB}=\mathrm{PLC} = 167^\circ\ 2'\ 46''$.

6. It is now necessary to compute the sides LC, MC, and BC, which will be found to be $\mathrm{LC}=17'\ 57''{\cdot}46$, $\mathrm{MC}=24'\ 56''{\cdot}84$, and $\mathrm{BC} = 16'\ 29''{\cdot}70$. Hence LC = 20·66 English miles, MC = 28·71, and BC = 18·98.

7. In the triangle PLM are given the sides PL, PM, and LM, to find the angles $\mathrm{PLM}=97^\circ\ 58'\ 24''$, $\mathrm{PML}=81^\circ\ 24'\ 48''$. If Napier's analogies be applied to the triangle LPM, these will be found to be $97^\circ\ 58'\ 34''$, and $81^\circ\ 24'\ 38''$ respectively. Also $\mathrm{PLM}+\mathrm{BLM}+\mathrm{CLB} = \mathrm{PLC} = 167^\circ\ 2'\ 46''$, as before. In like manner $\mathrm{PML}+\mathrm{LMC}=\mathrm{PMC}=123^\circ\ 39'\ 40''$.

8. In the triangle LBC are given the sides to find the angle $\mathrm{LBC} = 51^\circ\ 31'\ 32''$; and consequently, $\mathrm{LBC}+\mathrm{PBL} = 109^\circ\ 58'\ 42''$.

9. In the triangle PLC are given the two sides PL, LC, and the contained angle PLC, to determine PC the co-latitude $=34^\circ\ 2'\ 32''{\cdot}6$, and the latitude $= 55^\circ\ 57'\ 27''{\cdot}4$ N. deduced from the West Lomond.

10. In the triangle PMC are given the sides PM, MC, and the contained angle PMC, to deduce PC the co-latitude, and thence the latitude $= 55^\circ\ 57'\ 26''{\cdot}8$ obtained from the Isle of May.

11. In the triangle PBC are given the sides PB, BC, and the contained angle PBC, to find PC the co-latitude, and thence the latitude $55^\circ\ 57'\ 28''$ deduced from North Berwick Law. The mean of these three is $55^\circ\ 57'\ 27''{\cdot}4$ N.

12. In the triangle PLC there are given the three sides to find the angle PLC, the difference of longitude between the West Lomond and the Calton Hill $=7'\ 16''{\cdot}5$.

Hence $3^\circ\ 17'\ 4'' - 7'\ 16''{\cdot}5 = 3^\circ\ 9'\ 47''{\cdot}5$ W. by West Lomond.

13. Again, in the triangle PMC there are given all the sides to find the angle MPC, the difference of longitude between the Isle of May and the Calton Hill $=37'\ 5''{\cdot}6$ W.

Hence $2^\circ\ 32'\ 47'' + 37'\ 5''{\cdot}6 = 3^\circ\ 9'\ 52''{\cdot}6$ W. the longitude of the Calton Hill deduced from the Isle of May.

14. Lastly, in the triangle PCB, the sides are given to find the angle CPB, the difference of longitude between North Berwick Law and the Calton Hill $=27'\ 42''{\cdot}4$ W. Whence $2^\circ\ 42'\ 11'' + 27'\ 42''{\cdot}4 = 3^\circ\ 9'\ 53''{\cdot}4$ W. The mean of these three gives $3^\circ\ 9'\ 51''{\cdot}2 = 12^{\mathrm{m}}\ 39^{\mathrm{s}}{\cdot}5$ W.

In order to verify the latitude thus determined, I measured a base line on the road along the north side of the Calton Hill, with a hundred-feet chain constructed by Mr. Adie, in order

to

to connect the dome of the Observatory with the flagstaff in Leith Fort, (which was known to be nearly due North,) by means of angles taken at each extremity of the base. Now since the latitude of the flagstaff is known with considerable precision, from the observations of Captain Kater and M. Biot, whose pendulum observations were made in its vicinity, it follows that the latitude of the observatory,—if the requisite accuracy be observed in the connecting observations, which since the distance is inconsiderable do not require very fine instruments,—will also become known with a like precision.

The latitude of Leith Fort is, by Capt. Kater,	55° 58′ 41″ N.
by M. Biot,	55 58 37
Mean of these	55 58 39 N.
Diff. of latitude by the above observations trigonometrically	1 19 S.
Latitude of the Observatory	55 57 20 N.

I was considerably surprised at the difference between this and the preceding result 55° 57′ 27″·4, derived from the Trigonometrical Survey, and was unable to attribute it to any cause. Having suspected that it was owing to my supposing in this case the earth to be a sphere instead of a spheroid, I recomputed the whole with the reduced latitudes, without making much difference in the longitude, but with an increase of latitude of about 4″. In short, the resulting latitude was 55° 57′ 31″ N., and the longitude 12^{m} 39^{s}·8 W.

From observations made by Captain Stokes, R.N., and myself, with a good sextant by Troughton, it came out by the

sun to the south	55° 57′ 28″ N.
And by the pole-star to the north	55 57 12 N.
Mean by both	55 57 20 N.

This coinciding so exactly with that from Leith Fort, seemed to be a confirmation of it, and also a proof of the errors to which sextants made even by the best artists are liable, as has also been shown by Capt. Foster, R.N., in Capt. Sabine's book, page 408.

I had also in the beginning of the year 1826, found it by a

small circle to be	55° 57′ 21″·6 N.
And by one of Troughton's reflecting circles	55 57 19 ·3 N.
Mean of these is	55 57 20½ N.

From a consideration of all these circumstances, I was inclined with some confidence to adopt 55° 57′ 20″ N. to be the true latitude within a second or two, though I could not account

account for the excess of 11″ in that derived from the Trigonometrical Survey, after making all due allowance for the inferiority of my instruments and mode of applying them. I never lost sight of the subject whenever an opportunity presented itself; and at last found that the same discordances had occurred of nearly the same amount to a very distinguished practical astronomer, whose observatory is situated about 23′ S. of Edinburgh. I was most unwilling to admit that an error of that amount could possibly be committed in that great national undertaking, conducted by such eminent observers with such fine instruments. But what other conclusion was it possible to draw? No doubt the latitudes are only given to the nearest second in this part of the island; and consequently an error of half a second, amounting to about fifty feet in the *relative position* of the places observed, may have occurred by the method I have employed to derive the latitude of the Calton Hill from the Trigonometrical Survey; and this may have vitiated my conclusions in some degree, though I believe it to be small. It is true that the latitudes to the nearest second are as much, generally speaking, as can be depended on even by the best instruments, and sufficient for the nicest purposes; but for my purpose in this particular problem, it would have been better to have had the latitudes to fractions of a second, in order to keep up a consistency between the measured angles and their relative positions. It would, perhaps, seem impertinent in me to suggest any cause for this anomaly if my observations are correct, which, to a considerable extent, I am persuaded they are; and I sincerely hope that offence will be taken in no quarter, by merely attempting to clear up a difficulty that has occurred to others besides myself: more especially, if I am mistaken, I am most anxious to be put right. I have, indeed, attempted to account for it by the deflection of the plumb-line by the action of the dense strata at Arbury Hill, and by the consequent shortening of the length of a degree by that means deduced. The length of a degree a little south of this station, in latitude 52° 2′ 20″, is stated at 60820 fathoms, or about six fathoms less than would be derived from a spheroid of 0·00324 of compression at that latitude. Arbury Hill is only about 10′ 35″ N. of that latitude, or in 52° 12′ 55″ N.

Now if the latitude, for the reason assigned above, be supposed too great by about 5″; and since the latitude of Edinburgh is nearly 55° 57′ 20″, the difference is 3° 34′ 25″ N. =3·573. Whence 3·573 × 6 = 21·438 fathoms at the Calton Hill. Now at the mean latitude between these places, or at 54° 6′ 35″ N. the length of a degree is about 60850 fathoms, and

and a second equal to 17 fathoms; whence $\frac{21{\cdot}4}{17} = 1''{\cdot}2$, which added to $5''$ gives about $6''$, only half the error, or discrepancy observed. Again, The length of a degree at $52°\ 50'\ 30''$ is stated at 60766 fathoms; and taking this to be the length of a degree employed, we would have, as before, $15''$, without any attention to the deflection at Arbury, so far as regards the latitude. Hence it appears probable, that without constantly checking the latitudes by direct observation, an error equal in amount to what we have here found, may easily be committed. It is intended to be distinctly understood, however, that it is not affirmed by me that this is really the cause of the discrepancy I have noticed; but only as a probable explanation of it, which time alone will enable us to clear up. The longitude being still more difficult to verify, any discussion of it must for the present be deferred.

I am, gentlemen, yours, &c.

Edinburgh, Dec. 16, 1828. WILLIAM GALBRAITH.

P.S. If the same rate of error of longitude be allowed on that of Edinburgh, which Dr. Tiarks has found to belong to those of places on the south coast of England, from his chronometrical operations at Dover and Falmouth,—it ought to be increased by about two seconds; the longitude would be $12^m\ 42^s$ west; and even this I have reason to believe is nearly a second or two less than the truth. W. G.

XLI. *A Sketch of the Topography and Geology of Lake Ontario. By* J. J. BIGSBY, *M.D. F.L. and G.S., For. Mem. Amer. Phil. Soc. &c.*

[Continued from page 87.]

NEARLY the whole of this lake may be safely considered as based upon secondary rocks. Its east end, as far as Hallowell and Sacket's Harbour, on the north and south shores respectively, rests upon strata usually placed in the transition formation; while its extreme north-east angle is skirted by the primitive ranges of the north, which, stretching from Lakes Huron and Nipissing and from the River Ottawa, cross the outlet of Ontario (the Lake of the Thousand Islands) southerly in a band sixty miles broad, and overspread certain parts of the north of the State of New York.

Of these three classes of rocks I shall describe the primitive first, as far as I am acquainted with it; but confining myself to its southern and western borders. Other parts of it are sketched elsewhere.

All

All the portions with which we are now concerned seem to be contemporaneous; judging from their mutual conformableness, similarity of position, and from their containing the same characteristic minerals at distant intervals (schorl and magnetic iron ore). Like the older formations of Lakes Superior and Huron, I believe these to be the more recent of their class.

A line drawn E.S.E. from Penetanguishene (N.E. coast of Lake Huron) to Kingston on Lake Ontario, will represent with tolerable accuracy its southern limits so far. It is continued thence, nearly in the same direction, twelve miles down the outlet*; when suddenly an irregular S.S.E. or S.E. course is assumed to "Little Falls" on the Mohawk, twenty-six miles east of Utica. The connection between these ancient rocks in the neighbourhood of Lake Ontario, and those of Labrador and the northern dividing ridge of the valley of the St. Lawrence, has been satisfactorily established by tracing them up the Gananoque River to the townships of Perth, Lanark, &c. to the Lake and River Mississippi, which falls into the Ottawa at the lower end of its expansion called Lake Chat, and close to the southern limit of primitive rocks on that river. Setting out from Marmora, a township sixty miles W.N.W. from Kingston, Mr. Smith† in 1823 ascended through a primitive country to the same river Mississippi, by Crow Lake, Belmont River and Lake, and other water-courses.

In the interval between Lake Huron and Kingston, above referred to, consisting chiefly of lakes, woods and morasses, little more is known of this primitive range than its existence. Captain Macaulay, R.E. informed me that it lines the north-east shore of Lake Simcoe. It is gneiss there, apparently. Between that lake and Crow Lake‡ near the River Trent, I am informed that horizontal limestone advances from Lake Ontario fully to the boundary I have assumed; which, I may now add, just includes the marble and sienite of Crow Lake. This locality I have visited, and found to be composed of the above two rocks, interspersed with large beds of granular magnetic iron ore. On the river side, close to the Marmora Iron-works, I saw them in irregular contact, but much weathered. I could in no place discover stratification in either, excepting a doubtful W.S.W. direction in the ridges of sienite. The marble is in

* The large islands "Howe" and "Long," almost altogether wood and marsh, I believe to be of intermediary limestone. If they contain many gneiss mounds, the change in the course of the line drawn in the text will be less abrupt.

† One of the superintendants of Mr. Hayes's Iron-works at that place.

‡ Twenty-seven miles north from Lake Ontario, and about sixty from Kingston.

round

round-backed massive hills (lower end of Crow Lake), and is pure white, varying in its texture in patches from the compact to the saccharine and largely crystalline form.

I doubt not but that this rock is in very large quantities in these districts. I have crossed two large tracts of it on the Ottawa River, one being twenty miles broad. Another is met with on the western branch of that river, some miles east of Lake Nipissing. The north shore of Lake Ontario and the south side of Lake Simcoe present many large boulders of it.

The sienite forms broken sterile ridges, and is composed principally of translucent gray felspar, in rather large facets. The hornblende is in pale green and small-crystallized fragments, varying in quantity, and prevailing most near Foster's ore bed*. The little quartz it contains is colourless. Epidote

* There are numerous beds of ore in this vicinity, but the principal one is at the upper end of Crow Lake, at the water's edge. It is in the face of an acclivity about fifty feet high, covered with boulders of quartz, coloured by epidote and charged with magnetic iron ore. The whole eminence is probably a mass of ore, but at present the exposed portions are only sixty feet broad by ten in height. It is traversed by confused fissures, and is massive, jutting out in very large angular wedges. No rock appears in connection with it, being concealed by debris and vegetation. The ore is the granular magnetic, containing, however, much sulphur. Foster's bed, four miles and a half east of Marmora Works, and in the woods, seems exhausted. I could find nothing in the large excavation made in the sienite, but a few loose masses of ore, large fragments of calcspar filled with octohedral crystals of iron ore, and garnets. I also met with a minutely blended compound of hornblende, quartz, and garnet, having superimposed a new crystalline form of the first-mentioned mineral. Dr. Troost of Philadelphia has described it in a recent Number of the Journal of the Academy of Natural Sciences of Philadelphia, in the following words:

"Amphibole.—The specimen now under consideration, was at first very enigmatical. I was entirely misled by its crystalline form, so widely deviating from those usually presented by amphibole. In all the crystals of this mineral hitherto described, the faces M of the primitive form (Haüy) compose the greater part of the prism, and the summits have generally two or more faces. I was therefore much surprised to find the characters and composition which distinguish amphibole combined with the crystalline form now to be described. It is a rectangular prism, terminated in some of the crystals by an inclined plane, and in a few others by a dihedral summit. These crystals, which have a greenish and sometimes a black colour, with a rough surface, are divisible parallel to the four edges of the prism, forming the rhomboidal prism of the amphibole, the inclined planes forming an angle with one of the sides, of 105° 11′, and must of course be the face *l*; (see *Traite de Miner. de* Haüy. Atlas, pl. 64) so that we have 1 G 11 H 1 E;
x . s . l
and it approaches therefore to the *triunitaire* of Haüy, the faces M having entirely disappeared: the decrement which forms *l* has place sometimes on the two angles forming the dihedral summits; but the greatest part of the crystals on our specimens, having but one inclined plane, are the result of the decrement only on one of the angles."

abounds, both disseminated and in a multitude of slender veins, and particularly about the Iron-works*.

I have seen a fine specimen of actinolite-slate from the township of Hungerford, on the east of Marmora.

The great band of primitive rocks on the outlet (to which we have now come) I have repeatedly traversed, both on the water among its almost countless islands, and on its north shore. Of its south shore and vicinity I know nothing but from Mr. Eaton. Unless brought under cultivation lately, it is nearly in a state of nature.

By far the greater part of the rock here is a gray or reddish-brown gneiss, more or less granular, and containing but little mica and much quartz. It is often the case, that no grain, nor even component part, is distinguishable but on minute inspection. Its direction in all its numerous changes of form is always S.W. Its dip Mr. Maclure states to be S.E.; but so obscure is the divisiou into layers, and so great the disintegration in most places, that I could only satisfy myself of its being at a high angle, and often perpendicular.

The granular gneiss prevails particularly in the lower part of the outlet, and where the islets are most crowded, as about Wells's and Yeo's Islands. Among the varieties met with in crossing the band between Kingston and Brockville (towns sixty miles apart, situated on its western and eastern limits), are the following:

The hill of Fort Henry, near Kingston, consists of reddish large-grained gneiss, containing a good deal of hornblende, which prevails in large irregular patches, to the exclusion of other ingredients, as a greenstone. Much of the south-west rampart of Fort Henry rests upon this latter form of rock, close-grained, and sprinkled with a few nests of mica, and ferruginous red clouds. The paler gneiss of Cedar Island and its contiguous tongue of land, contains a good deal of epidote, in crystals lining fissures and in veins. At the romantic pass by which Kingston River enters the lake, four miles and a half north-east from the town, the rock abounds very much

* Here the sienite forms the base of a cliff on the left side of the river, and supports alternating layers three or four feet thick (altogether), of red, gray, and grayish-green argillaceous sandstone, of very fine grain, and smooth to the touch. On this again rests a very compact light-brown limestone, of conchoidal fracture, dim lustre, and often studded with small masses of hyaline calcspar, like the limestone of the Narrows of Lake Simcoe. The cliff is about twenty-five feet high; but it has in its immediate rear a ridge two hundred feet in height, wholly composed of this limestone, darker however, and coarser, in the upper parts. There are no organic remains here; but much of the horizontal suture-like divisions which will be afterwards described as occurring strongly marked at Niagara and Kingston.

in

in hornblende, and near the cascade is quite the same as the sienite of Markfield Knoll, in Leicestershire.

On the north shore of the outlet, about three miles north-east from Kingston*, and not far south from the sienite, the ridges are of highly crystalline milky quartz, with a strong tinge of blue, and spotted with iron rust. Whether these strata be interposed, or result from a gradual change, I had no means of learning. From observing a conglomerate, whose nodules are of this rock, in many parts of this neighbourhood, and from its fragments being frequent south-west even as far as Lake Erie, I believe the milky quartz to be in great quantity. At the "Marble Falls," on the River Gananoque, four miles and a half from the St. Lawrence, there are ridges which are a mixture of noble serpentine and white marble. The former is pale and dark green; its lustre and translucency (at the edges) considerable: it is disseminated through the marble in shapeless lumps of every size, sometimes few in number, and at others constituting the greater part of the mass: or again, it is intimately blended with it in clouds and convolutions. It is in thick blocks. I have not seen it *in situ*. It occurs also near Gananoque Lake. Twenty miles east of Gananoque village, on the high road to Montreal, two or three miles north of the St. Lawrence, the mica is in small brownish yellow scales; so abundant, and the rock so slaty, that it becomes a mica-slate, with a vertical dip and S.W. direction.

Thirteen miles west of Brockville, on the same road, we pass for three miles through a district of white translucent quartz in mounds, steep, shapeless, often ruinous, but still often betraying in its rents a south-west direction. It is fine granular, passing into crystalline. One of these eminences, thirty or forty feet high, half a mile north from the road, and near the easternmost of two creeks occurring here, has a vein of iron pyrites under the following circumstances. It is at the bottom of a rounded cavity twelve feet deep and as many long, but not quite so broad; its sides consisting of very shattered quartz, spotted with brown oxide of iron, and covered profusely with an efflorescence, yellow and white, of sulphate of alumina. The lower parts are studded with small masses of iron pyrites. The vein itself is one foot and a half thick, and disseminates itself into the surrounding rock. It is visible for one yard and a half. It was discovered seventeen years since by a man who was seeking his cow in the woods. He was within a short distance of the spot, and on a sudden was startled by a tremendous explosion, attended by volumes of smoke and sul-

* On the farms of Messrs. Law (late naval storekeepers) and Mr. M'Kenzie, (commander of the steam-boat Frontenac.)

phurous odours. On visiting the seat of the disturbance, he found the appearances I have described.

The north shore of the St. Lawrence, three miles and a half above Brockville, and a small group of islands, seven miles above that town, are principally of fine granular gneiss; but in both places it becomes porphyritic, and red. It is there traversed by granitic veins, whose white quartz, red felspar, and copper-coloured mica, are in crystalline masses, varying from one to three inches in diameter. Quartz veins are frequent everywhere.

Iron pyrites, in very large quantity, is common throughout the distance from Kingston to Brockville. Magnetic iron ore occurs high up the Gananoque River, and on an islet in the St. Lawrence, one mile south-west from the mouth of the Gananoque. Plumbago occurs in a creek six miles N.E. of Kingston. The late Mr. Spilsbury, surgeon R.N., showed me some good specimens. It is found also on Gananoque Lake (Gourlay). The only other mineral belonging to this district, with which I am acquainted, is schorl. This is plentiful everywhere: there are perhaps few islands in the outlet without it; it is imbedded also in the crystalline quartz rock.

A considerable mass in confused crystallization exists three miles and a half below Kingston on the water side; but the most remarkable locality is Yeo's Island*. This island is small, naked, and high, divided into two parts; on the summit of the south-western of which is the bed of schorl, twelve feet in diameter. It does not consist of schorl only, but is a confused aggregate of white translucent quartz, of opaque cream-coloured felspar, of greenish yellow mica, and the schorl is intermixed in shapeless masses of from one to three feet in diameter. The quartz and felspar are in their usual forms. The mica is brass yellow, but with a delicate tinge of green in certain lights. It is in flakes an inch square, grouped confusedly, and so tough, that, although it is in masses of a yard in diameter, small fragments are procured with difficulty with a large hammer. The schorl occurs as a very close accretion of large crystals, with broken terminations, cemented by a film of mica, and dipping into the rock southerly, at an angle of 70°. They have no determinate number of sides; but resemble a *fascis*, composed of unequal rods. From this the principal deposit, several ramifications of like materials pass off to the sides of the island, wanting only the mica. Veins of felspar and quartz, very largely crystallized, are met with in other parts of the island, containing schorl in six-sided prisms from 1 to 8 inches in length.

* Opposite M'Guggin's tavern, and outside of the head of Tar Island.

Of

Of the continuation of the primitive band of the outlet into the State of New York, what little is known may be summed up in the following words of Mr. Eaton: "It consists of mountain ridges of gneiss, with intervening valleys of transition sandstone and limestone. The gneiss is more nearly in an horizontal position than is usual for rocks of gneiss in New England. All these mountain ridges may be called by the general name, 'Macomb's Mountains*.'" It is bordered on the south by transition rocks in the valley of the Mohawk.

The gneiss "seems to be what Cleaveland calls 'the most recent variety,' and often contains but little felspar or mica. Sometimes it passes into an almost pure quartzose sandstone, and frequently passes gradually into siliceous limestone†."

The geologist who confines himself to the margin and islands of Lake Ontario, will be much puzzled in the distribution of the rocks above the primitive. Excepting its lower eighty miles, chiefly occupied by submedial limestone, the north main is so covered with diluvium, that for many miles in-land (as well as on the beach) few fixed rocks show themselves. He will find conglomerates, sandstones and limestones (apart), succeeding each other on the same level, in ledges or cliffs, surrounded by marshes, waters, or woods; as far as the eye can discover, they are all in horizontal layers: but it is to be remembered, that the sections of stratification thus presented are very deceptive, and that in platforms of small extent (as they usually are here) a great aberration from horizontality will escape the unassisted eye. Little aid is derived from the contents of these limestones, organic or mineral; they are nearly the same.

However, on the north shore itself, the relations of the three lowest of these rocks are well ascertained; while on the south shore, and more particularly in the adjacent parts of the State of New York, a very satisfactory display is made of the whole. These latter districts have been examined with zeal and ability, at the expense of the Hon. Steph. Van Renssellaer, by Mr. Amos Eaton‡, in his Geological Survey quoted above. The enlightened patron of this investigation allowed Mr. Eaton two industrious and well-informed assistants, Messrs. Webster and Eights, and assigned no limits to his very considerable expenses§.

I have

* Geological Survey of the District adjoining the Erie Canal in the State of New York. Albany, 1824. page 43. † Ibid. page 52.

‡ Professor of Chemistry and Mineralogy at a College in Vermont.

§ This survey was performed in the summers of 1822 and 1823. Mr. Eaton made the line of the Erie Canal his principal object, but occasionally left it on either side, as far as twenty miles, in search of geological facts. It is

360 miles

I have visited some of the most interesting localities described by Mr. Eaton:—as the Mohawk Valley, the Rivers Genessee and Niagara, and the Excavations at Lockport; and can so far bear testimony to the fidelity of his observations. The utility, I may be permitted to remark, of certain changes in nomenclature introduced by this gentleman, is very questionable. I have seen nothing to justify the application of the term "grauwacke" to nearly horizontal and usually shaly and homogeneous rocks above the salt-formations, and abounding in organic remains. Whenever they are not strictly argillo-calcareous slates, they are sandstones, with a base of clay or lime. The old words limestone and sandstone seem to me as proper as the "lime-rocks" and "sand-rocks" of Mr. Eaton. If by the appellations "geodiferous," "cornitiferous," &c. given to certain strata, pretty uniform in their situation and characters over a great extent of country, it be only intended to show them to abound in geodes, cherts, &c. *they* are allowable.

The rocks forming the basin of Lake Ontario may be enumerated as follows, beginning from below:

Gneiss	Outlet and N.E. angle.
White sandstone and conglomerate, quartzy and calciferous }	Outlet and Macomb's M^{ts}.
Carboniferous limestone (metallif. of Eaton) ..... }	East end.
Metalliferous grauwacke (Eaton)	Near Utica, &c.
Millstone grit (Eaton).....	Ditto.
Saliferous and ferriferous sandstone (Eaton) ..... }	South shore, and Niagara.
Argillo-calcareous strata (calciferous slate of Eaton) ..... }	Ditto.
Compact limestone, the lower part full of geodes, the upper full of chert ..... }	Genessee, Niagara.
Calcareous shale (pyritiferous)...	Near Ithaca, and Lake Erie.

While the gneiss, wherever I have seen it, is at a high angle, these rocks are very nearly horizontal, inclining from the nearest primitive ranges, so as to allow a succession of rocks to appear at intervals in the lake, or in its vicinity at the same level; the oldest being at its east end, and the newest at the west. They are spread out in close contact (many, if not all,

360 miles long, and commences near Albany, on the Hudson River. It ascends the valley of the Mohawk, and passing a little south of Oneida Lake, approaches within six miles of Lake Ontario at the River Genessee. From thence, very slowly receding from the latter body of water, it pursues a western course to Buffaloe, at the east end of Lake Erie.

passing

passing into each other) in very slightly concave layers of vast extent, but of comparatively small thickness. It is almost certain that they underlie the lake itself. On the north shore, although the salt formations have never yet been seen, numerous springs of brine sufficiently attest their presence.

In describing these rocks, I shall begin by stating by themselves the results of Mr. Eaton's researches, which have been much more minute than mine, on the middle and upper portions of the series. I shall then describe the rocks incumbent on the gneiss at the north-east end of the lake and in its outlet, which differ from their equivalents in the Macomb Mountains, as detailed by Mr. Eaton.

Rocks of the South Side of Lake Ontario.

The gneiss has been described.—Inclining upon it, Mr. Eaton found on the west side of the "Little Falls*" a rock, which he calls "calciferous sand-rock," or "transition calcsand." He describes it as an aggregate of quartzose sand and fine grains of carbonate of lime, in variable proportions, the quartz generally predominating. On exposure, the calcareous part soon disappears, leaving the surface a mere siliceous sandstone. It abounds in geodes, often lined with quartz crystals. It is very irregular in its form and structure; sometimes compact, more commonly cellular, and full of druses. It contains in small disseminated masses, or in geodes, anthracite-coal, sulphurets of lead and zinc, green carbonate of copper, lamellar barytes†.

This rock, at the above-mentioned place "spreads out to a considerable breadth. Six miles north of the canal it may be seen passing under the limestone (carbonif.), a little west of the ridge (of the Little Falls). Near West Canada Creek‡, it emerges from beneath the same rock, towards the bottom of a hill. It may then be seen forming the banks and bed of the creek for several miles. It evidently leads away thence in a north-west direction toward the outlet of Lake Ontario§."

Until the country here be more cleared, and observations be more multiplied, no very distinct idea can be furnished of the form and extent of this rock. It is most probably a narrow band, whose length runs north, and at its west border dipping under the next rock, the metalliferous rock of Eaton, the carboniferous of Conybeare. Mr. Eaton only adverts to the stratification of the calciferous sand-rock, in mentioning (as above) that it inclines upon the gneiss. He speaks of it as

* 106 miles E. of Lake Ontario.
† Geological Survey, p. 32.
‡ North of Utica.
§ Geological Survey, p. 76.

common

common on the Hudson and on Lake Champlain. It skirts the ridges of gneiss at the margin of all the valleys among Macomb's Mountains, and entirely surrounds the spurs of gneiss which cross the Erie Canal at the Little Falls and the Noses*.

Carboniferous Limestone.—Following the series upwards, the next rock we arrive at is the metalliferous limestone of Eaton, which is the "carboniferous" of Conybeare and Phillips, and the "intermediaire" of D'Aubuisson in every respect but its extremely small inclination. Eaton defines it thus: It is "more or less compact, opaque, fracture conchoidal and scaly. It is frequently cellular, containing small disseminated masses of calcspar in scales. It is sometimes slaty, but then each lamina or layer is compact. It is not traversed by veins of calcspar, like sparry lime-rock; a kind of bark-like ferruginous slate is often interposed in the natural cleavages. Its upper surface contains petrifactions. Colour generally gray or slate colour†."

This rock "is nearly co-extensive with the calciferous sandrock; wherever the sandstone skirts the ridges of gneiss, the limestone overlays it, generally commencing from one to three or four miles from the foot of the gneias range."—(G. S. p. 82.) "It forms a large band stretching to the north-east end of Lake Ontario‡, in a curvilinear course, from the point of (Little) Fall Hill, by the way of Fairfield, Newport, Trenton, &c., with its south margin about eight miles N. of Utica, and ten miles N. of Rome."—"In all this extent it is separated from the secondary rocks by a belt of grauwacke, under which it passes at its south-western edge."—(G. S. p. 83.)

Mr. Eaton does not mention the position of its strata. At the east end of the lake they are nearly horizontal. Professor Renwick found them so at Trenton also.

Grauwacke next succeeds, according to Mr. Eaton, and is

* A pass of the Mohawk between high hills, 26 miles E. of Little Falls.

† Geological Survey, p. 33.

Professor Renwick of New York, in vol. ii. p. 186 of the Annals of the Lyceum of that city, has given the following sketch of the mineral characters of this rock, at Trenton Falls near Utica, a part of the tract traced by Eaton; considering it to be the submedial limestone of Conybeare:—At this place the strata are open to view for a depth of three hundred feet. They are of various thickness, and are parted by thin seams of argillaceous matter. The higher layers are composed of carbonate of lime, nearly pure, of a light gray colour and crystalline structure, easily separable into rhombic crystals. At greater depth, the substance becomes more compact, of a darker gray colour, and finally quite black: it is then highly fœtid. The lower strata are susceptible of a high polish. Fossils are very abundant, and in some cases form nearly the whole mass.

‡ I have seen it *in situ* at Sacket's Harbour.

described

described by him as an aggregate of angular grains of quartzose sand, cemented by indurated clay, and generally containing glimmering scales of mica and talc. A coarse variety called Rubblestone (common grauwacke) is very hard, and contains large pebbles and fragments of argillite, slaty grauwacke, &c. Glimmering scales are rare, or wholly wanting in this variety. Colour generally gray.—(G. S. p. 33.)

This is a very prevalent rock in the east part of the State of New York. West of the gneiss ranges of the Little Falls, it runs along northerly from two to three miles S. W. from the Mohawk, about the same distance S. of the west branch of Fish Creek and of the Salmon River, until it meets the S.E. corner of Lake Ontario. It thus forms a belt from 8 to 10 miles broad, between the carboniferous limestone, and a stratum called by our author "millstone grit," under which it is seen to pass at Steel and Myer's Creeks, &c.

The grauwacke (which I have never seen but in rolled masses) underlies the Erie Canal for twenty miles east of Utica. From the direction of its strata being nearly horizontal, or being in a very gradually descending inclined plane, Mr. Eaton conjectures that it underlies at no great depth (from 5 to 800 feet) all the western part of the State of New York. It does not appear in view, however, any where immediately adjoining the Erie Canal, west of Utica.—(G. S. p. 85.)

I am not aware of any foreign minerals having been met with in this rock, near Lake Ontario. On the Hudson and Susquehanna Rivers, sulphuret of lead and manganese have been found in many places: anthracite-coal, near Troy.

Millstone Grit, (a rock so named by Mr. E.,) rests upon this grauwacke. He classes it with the English rock of that name, supporting the coal-measures. It is a coarse, harsh, aggregate of quartzose sand and pebbles, without cement. It is gray, or yellowish, or reddish gray.—(G. S. p. 35.)

It underlies the new red sandstone (the saliferous rock of Mr. E.), and accompanies it wherever it crops-out. From ten miles S. of Little Falls, all the way in a north-west direction to the S.E. corner of Lake Ontario, and for fifty miles west from the first-mentioned point. Wherever the "millstone grit is laid bare in ravines, &c., we see the saliferous rock lying immediately upon it."—(G. S. p. 97.)

This stratum, when it appears in full thickness, is from forty to sixty feet thick, in several perpendicular ledges. It does not pass into or alternate with the grauwacke upon which it lies. All the rocks, above it and accompanying it, are much harder at and near where they crop-out, than in Oswego, Genessee,

or Niagara Rivers. (G. S. p. 98.) It is to be remarked, that no coal has been found between the "millstone grit" and the new red sandstone, although they have been frequently seen in contact.

[To be continued.]

XLII. *On Transits.*

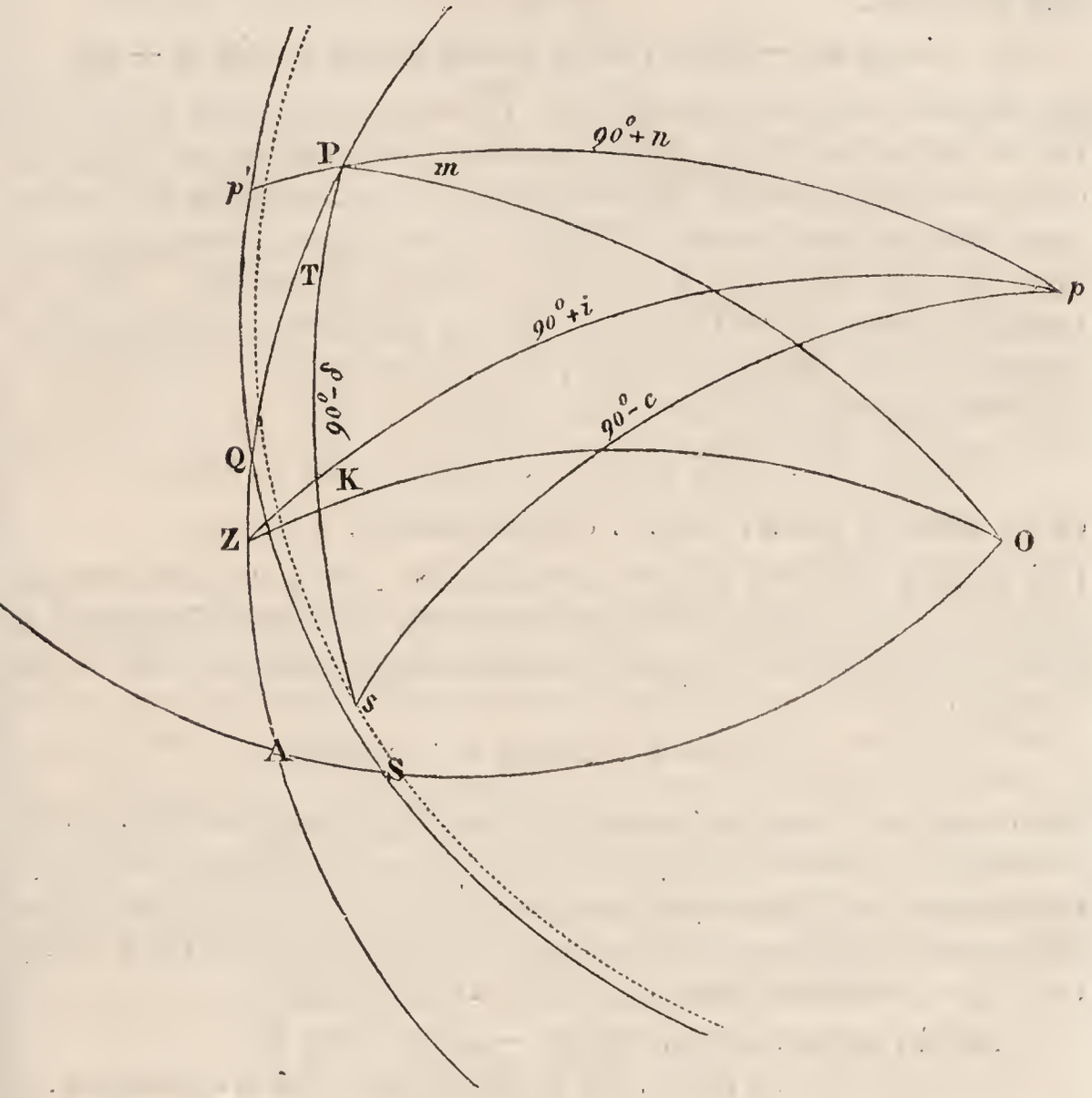
(*From* Prof. Encke's *Astronom. Jahrbuch for* 1830, *p.* 305.)

THE excellent papers by M. Hansen and Prof. Bessel in the late Numbers of the *Astron. Nachr.*, have rendered superfluous the explanation of the use of the transit for determining time and latitude which was intended for this volume; and the only part which I deem it proper, therefore, to insert in this place, is the rigorous derivation of the formulæ for determining the former of these elements. This subject has already been treated by Prof. Bohnenberger in the Journal of Astronomy. I have endeavoured to render the rigorous formulæ as nearly similar to the approximate ones as possible. On the supposition of the true figure of the pivots, the line of vision of a transit will in every position describe a great circle, if placed at right angles to the axis of rotation. If the instrument has what is called an error in collimation ($= c$), the line of vision describes a small circle parallel to the great circle, the distance of which from the other in parts of the great circle is everywhere $= c$. If we suppose that the axis of rotation is produced to the sphere, and call the points in which it intersects the surface of the sphere its *poles*, nothing will be required in order to have a perfect knowledge of every position of the instrument, but the position of one of these poles with regard to known planes and points and the quantity c. For the purpose of determining time, the most proper plane to which the position of the pole can be referred will be the meridian. We may assume for the fixed point in this plane from which the angles are counted, either the pole or the zenith, or both at the same time. The first assumption gives the formula which M. Bessel has introduced, the second the formula of Mayer, and the third that which M. Hansen has used at Heligoland.

Let PZA be the meridian, P the pole, Z the zenith, A the point of intersection of the equator, O the east point, p the eastern pole of the axis of rotation, Sp' the great circle, which the instrument would describe if $c = o$, the dotted circle the one which it actually does describe in the case of a given c, and let its distance from p'S $= c$ be positive if eastern. In order

order to refer the position of p to the meridian, pole, and zenith, let the following designations be assumed:—

$Zp = 90° + i$ angle $AZp = 90° + k$
$Pp = 90° + n$ angle $APp = 90° + m$



S the point of intersection of Sp' and the equator, being a pole of the great circle Pp, m will likewise be measured by the arc AS. The quantities m and n are consequently the same as Bessel's. The former is the distance of intersection of the plane perpendicular to the axis of rotation and the equator, counted from the meridian; the latter is the distance of this perpendicular plane from the pole of the heavens, both positive, if eastern.

Between the quantities i, k, m, n, the triangle PZp gives the following relations, supposing the latitude $= \phi$.

$$\sin n = \sin i \,.\, \sin \phi - \cos i \,.\, \sin k \,.\, \cos \varphi$$
$$\sin m \,.\, \cos n = \sin i \,.\, \cos \phi + \cos i \,.\, \sin k \,.\, \sin \varphi.$$
$$\cos m \,.\, \cos n = \cos i \,.\, \cos k$$
$$\sin i = \sin n \,.\, \sin \phi + \cos n \,.\, \sin m \,.\, \cos \phi$$
$$\sin k \,.\, \cos i = -\sin n \,.\, \cos \phi + \cos n \,.\, \sin m \,.\, \sin \varphi.$$

Assuming that a star whose declination is $= \delta$ is in the real line of vision in s, and calling τ the hour-angle which is to be added to the observed one, in order to obtain the time of the star's passage over the meridian, we have in the triangle Psp this equation.

(I) $\sin c = -\sin\delta \cdot \sin n + \cos\delta \cdot \cos n \cdot \sin(\tau - m)$

by which τ is to be determined. This equation, from which all the others are derived, is true both for the superior and inferior culmination, provided, for the latter, δ is counted from the same semicircle of the equator ASO as for the former; passing, therefore, through the pole, δ is to be increased above 90°. This is usually expressed by the rule, that for the lower culminations, instead of the real declination, its supplement is to be taken.

From equation (I) we obtain this:

$$\sin(\tau - m) \cdot \cos n = \sin n \cdot \operatorname{tang}\delta + \sin c \cdot \sec\delta$$

or by adding $\sin m \cdot \cos n$. on both sides:

(A) $2 \sin\frac{1}{2}\tau \cdot \cos(\frac{1}{2}\tau - m) \cos n = \sin m \cdot \cos n + \sin n \cdot \operatorname{tang}\delta + \sin c \cdot \sec\delta$, from which the formula of Bessel, in which p is only referred to the pole, is immediately derived. It is as follows:

$$\tau = m + n \cdot \operatorname{tang}\delta + c \sec\delta.$$

As n may be found by observations of circumpolar stars, but m cannot be found by any direct method, it becomes necessary to combine with this equation the 4th or 8th of the above relations, according as i can be more accurately found by a level, or k by a meridian-mark. Those relations give

$$\begin{aligned}\sin m \cdot \cos n &= \sin i \cdot \sec\phi - \sin n \cdot \operatorname{tang}\varphi \\ &= \cos i \cdot \sin k \cdot \operatorname{cosec} \cdot \varphi + \sin n \cdot \operatorname{cotang}\phi.\end{aligned}$$

The factor, $\cos(\frac{1}{2}\tau - m) \cos n$ is the cosine of the angle at which the great circle bisecting τ intersects the circle Sp', and $\cos m \cdot \cos n$ is the angle of Sp' and the meridian, at their point of intersection Q. The distance AQ is obtained by the equation $\operatorname{tang} AQ = -\frac{\sin m}{\operatorname{tang} n}$.

If we substitute on the right-hand side of (A) the first and second relations, we have

$$\begin{aligned}\text{(B)}\quad 2 \sin\tfrac{1}{2}\tau \cdot \cos(\tfrac{1}{2}\tau - m) \cdot \cos n &= \sin i \frac{\cos(\varphi - \delta)}{\cos\delta} \\ &+ \sin k \cdot \cos i \frac{\sin(\varphi - \delta)}{\cos\delta} + \sin c \cdot \sec\delta\end{aligned}$$

answering to Mayer's formula:

$\tau = i \cos z \cdot \sec\delta + k \sin z \cdot \sec\delta + c \cdot \sec\delta$, in which p is referred to the zenith only.

If the relative positions to the pole and the zenith are both

to

to be used at the same time, one may choose between the combinations of m or n with i or k. These combinations, after eliminating from the equation (A) the proper quantities by means of the relations above given, give the following expressions:

$$2 \sin \tfrac{1}{2}\tau \,.\, \cos(\tfrac{1}{2}\tau - m) \cos n$$

$$= \sin i \,.\, \sec \phi \quad - \sin n \left(\frac{\sin(\varphi-\delta)}{\cos\delta \,.\, \cos\varphi}\right) + \sin c \,.\, \sec\delta$$

$$= \sin k \,.\, \cos i \,.\, \operatorname{cosec}\varphi + \sin n \left(\frac{\cos(\varphi-\delta)}{\cos\delta \,.\, \sin\varphi}\right) + \sin c \,.\, \sec\delta$$

$$= \sin i \,.\, \frac{\operatorname{tang}\delta}{\sin\varphi} + \sin m \,.\, \cos n \left(\frac{\sin(\varphi-\delta)}{\cos\delta \,.\, \sin\varphi}\right) + \sin c \,.\, \sec\delta$$

$$= -\sin k \,.\, \cos i \frac{\operatorname{tang}\delta}{\cos\varphi} + \sin m \,.\, \cos n \left(\frac{\cos(\varphi-\delta)}{\cos\delta \,.\, \cos\varphi}\right) + \sin c \,.\, \sec\delta.$$

The first of these formulæ, the one which M. Hansen has chosen, is the most convenient. It may be thus represented:

$$\tau = i \sec\varphi - \sin n \,.\, \sin z \,.\, \sec\varphi \,.\, \sec\delta + c \,.\, \sec\delta$$

It contains only the quantities i, n, and c, which may be directly determined by observations. It shows also most clearly, that with equally good instruments, and consequently equal uncertainty in the values of i and n, the uncertainty of the determination of time increases with the altitude of the pole.

If the observation is made at one of the lateral wires, the distance of which from the point for which c has been determined, is called $= f$, taken positively in the same sense as c above, and if we call t the hour-angle which is to be added to the observation at the lateral wire, in order to reduce it to the meridian wire, we have the two equations:

$$\sin(c+f) = -\sin\delta \sin n + \cos\delta \cos n \,.\, \sin(t+\tau-m)$$
$$\sin c \quad = -\sin\delta \sin n + \cos\delta \cos n \sin(\tau-m)$$

whence $\sin t = \sin f \sec\delta \left\{ \dfrac{\cos(c+\frac{1}{2}f)}{\cos\frac{1}{2}f} \cdot \dfrac{\cos\frac{1}{2}t}{\cos(\frac{1}{2}t+\tau-m)} \sec n \right\}$

from which we derive the usual form for declinations which are not too large $t = f \sec\delta$.

And for stars near the pole

$$\sin t = \sin f \sec\delta.$$

If the object of the observations be to determine differences of right ascension, Bessel's formula is the most convenient; because in that case it is not required to use the constant m. For absolute determinations of time, the formula of M. Hansen is more advantageous.

XLIII. *Researches on the Anatomy of the Brain. By* Dr. Foville, *Principal Physician of the Lunatic Asylum for the Department of the Lower Seine, &c.; to which is prefixed* M. de Blainville's *Report on the Subject to the Royal Academy of Sciences.*

To Richard Phillips.

My dear Friend,

I HAVE been favoured by my friend Dr. Foville, of Rouen, with a copy of his interesting memoir on the Anatomy of the Brain, presented some time since to the French Academy of Sciences; and likewise with a copy of the report drawn up by Professor Blainville, one of the examiners, to whom the memoir was referred by the Academy.

These papers have not yet been printed in France, but the Doctor has obligingly consented to their publication in this country; and I have in consequence made the accompanying translations, which are now at thy service.

To those who may be unacquainted with the name of Dr. Foville, it affords me pleasure to have this opportunity of offering my testimony to his talents, and to the steady zeal with which he has devoted himself to his profession.

At the Salpetriere and at Bicêtre he long enjoyed uncommon advantages for the prosecution of those branches of study which are more particularly connected with the subject of these papers.

Some of the anatomical facts which the Doctor has brought to light were demonstrated to me by himself more than three years ago. He has since shown me others equally curious, which I believe he is now about to make public.

Thine truly,

New Broad-street, 9, 1st month, 1829. Thomas Hodgkin.

[The perpetual Secretary of the Academy of Natural Sciences certifies that the following is an extract from the proceedings of the meeting of the 23rd of June 1828.]

The Academy at its meeting of the 24th of March last, referred to us for examination, a memoir presented to it by Dr. Foville, who was long attached to the service of the hospitals of Paris, and who is now chief physician to the Lunatic Asylum at Rouen. The researches contained in this memoir relate to the anatomy of the brain of man only; they are not extended to the most nearly related species, and of course do not notice the inferior divisions of the osteozoa.

The study of the composition and arrangement of the central part of the nervous system, that is, of the spinal cord and brain,

brain of man, has at every period in which anatomy has been at all minutely cultivated, necessarily arrested the attention of the most celebrated anatomists. We learn this from the history of anatomical science from the time of the school of Alexandria, down to Gall and Spurzheim, who in our own day have given to this kind of research an impulse and direction altogether new.

In this part of our structure it is not surgical anatomy with which we have to do. Hitherto the bold hands of our most distinguished surgeons have not ventured to carry the scalpel into parts so delicate, and possessing so intimate a connection with the continuation of life. It is a higher description of anatomy:—it is physiological anatomy, of a nature necessarily somewhat speculative, which must direct the knife. Not that it is to endeavour to resolve questions inaccessible to human reason, such as, Where is the seat of the soul? What is its mode of action? and What is the relation which it bears to material substance?—but it must see if it be possible by analysis to discover what parts are particularly connected with the intellectual faculties, what with the senses, and what are connected with motion.

To resolve, or at least to throw light on these great questions, of the difficulty of which we are perhaps not even now sufficiently aware, various means have been employed, according to the different manner in which the subject has been considered; and also according to the progress of biology, or the science of life.

The first method which offers itself, and that which in fact has been followed by most anatomists, is to examine the organ by itself, in the human subject, in its healthy state, and when arrived at its full development. But it was necessary to effect something more than a superficial examination of the form and proportion of the parts, and to penetrate into the interior more completely than could be done by merely making different horizontal and vertical sections, as was generally the practice before the time of Gall and Spurzheim. It was not with the brain and spinal marrow, as with the other organs, that a simple surgical anatomy was required. This would be all but useless; since it scarcely ever happens that an operation is required to be performed on these parts.

A second method, which it will be conceived possessed a superior degree of influence on our knowledge of the mysterious seat of our faculties, consisted in embracing the opportunity which design or accident afforded for comparing the cerebro-spinal system of man, with that of the animals the most nearly related to him.

Although

Although in this method, in common with the preceding, the examination was superficial, and limited to the form and proportion of the parts, it necessarily led to the assigning of particular functions to at least some of the parts of the organ; the coincidence being observed between the intellectual peculiarities of this or that animal, and the development of this or that part of its nervous system. Errors would necessarily be committed; but it is evident that by this means, after a greater or less number of unsuccessful attempts, some certain results might be obtained.

A third method soon presented itself to the biologist;—one which could not fail to be of much greater importance and value in relation to the physiological anatomy of the brain. It consists in carefully studying the connection between the more or less chronic morbid alterations of this central and essential part of the nervous system, and the functions of the intellect, of general or special sensibility, and of locomotion, in order to advance from functions to organs; since it was impossible from the organs to infer their functions. But, in order properly to employ this method, it was necessary, as will be readily perceived, that the healthy or regular state of the organ should be exactly determined, as well as the variations to which it is liable, both as a whole and in its parts, according to age, sex, temperament, individual peculiarity, or *variety of race;* and this not with respect to form only, but with relation also to intimate structure. Thus we are brought back to the necessity of perfecting the first method.

This step was still more necessary to regulate the use of a fourth, and much more difficult, method; namely, that of experiments consisting of operations by which, in general, the parts are more or less suddenly altered,—a method which is liable to be still more deceptive in this than in any other branch of physiology. Hence the very contradictory opinions which we find adopted by experimental physiologists. In fact, when we reflect that the parts of the brain are neither limited, nor perfectly circumscribed; that in wounding or removing these parts with the bistoury we do not see what we are touching; that the action is immediate, violent, and sudden; that the consequent disturbance of function in the living animal being complex, cannot be the faithful and certain interpreter of the injury,—we may conceive how difficult is the application of this mode of arriving at the true knowledge of the functions of the centre of the nervous system, however skilful and well-practised the hands of the experimenter may be.

These observations are also to a certain degree applicable to the method of employing medicinal substances for the purpose

pose of experiments on the nervous system, whatever be the mode in which they may be introduced into the animal œconomy. We see, indeed, that after such an application, a particular phænomenon is produced, and that a particular change takes place in a particular faculty. But, first, the phænomenon is often a complicated one; and secondly, it is very rarely, if ever, possible to discover the part or organ which has been affected. Hence the difficulty of ascertaining by this method the special functions of the particular parts of the nervous system.

As to the method which consists in studying the nervous system in its progressive development, from the moment at which it first becomes perceptible to our senses, until its formation is complete, and thence through all its changes, as the animal arrives at its full maturity and afterwards descends to a senile death; and in analysing the corresponding progress in the growth and the decline of the intellectual, sentient, and locomotive functions;—this is evidently a more solid and an easier method, because it is anatomical. But it stands in the closest relation to the first method.

Next, and lastly, I shall speak of the fifth or metaphysical method; since, in fact, it is the most modern, and that which evidently has led Drs. Gall and Spurzheim to their mode of viewing the anatomical conformation of the nervous system.

It is not difficult to conceive the possibility of analysing, *a priori*, all the functions of the intellect, of sensibility, and of locomotion; of systematizing them, and of subsequently seeking in the organized structure a corresponding arrangement. It is this new direction which has diverted anatomists from the beaten track, to which they had attached themselves before the labours of Gall and Spurzheim. Had Gall and Spurzheim done nothing but this, and moreover, were all the points of their anatomy to be successively contested and completely refuted, there would still remain to them the honour of having discovered a new impulse; and consequently to them must be referred, as to its source, all that may be valuable in future labours on this subject.

From this preliminary analysis of the means which may be employed to enable us to form some conception of the physiology of the brain, it is evident that the chief and most important one, and that without which all the others must fundamentally err and be devoid of all certainty, is the minute internal as well as superficial anatomy of the human brain, in its adult, perfect, and healthy state. Without this point to start from, all must be precarious. It is the rule by which all the rest must be measured. How in fact shall we be able to say

whether a particular morbid symptom corresponds or not with a particular alteration in the development or structure of a certain part of the brain, if the healthy state of that part is not accurately known, and if, further, we are ignorant of the limits to the variations of which that part is susceptible? Can it be possible to point out the steps of degradation in the scale of animals, with respect to this most important part of the organization, if the point whence we are to set out has not been justly established? How shall we be able to draw a conclusion respecting the use of a part, from experiments made on animals, in which we are not sure that the part in question exists?

We do not hesitate therefore to assert, that notwithstanding the works of greater or less importance which (with more or less candour and accuracy) have within a few years been published by anatomists of all the nations of Europe, the cerebro-spinal nervous system is a field in which there still remains to be made, not a scanty gleaning but an ample harvest. But for this purpose it is essential that our researches should be directed to the human subject. It is in our own species alone that we can analyse the functions allotted to the nervous system,—man almost exclusively being subject to those diseases and alterations of the brain, of which the effects can be appreciated by comparison. It is then a happy omen for the work of Dr. Foville, to observe, that his researches on the brain have commenced with the adult healthy brain of man. In order that his labours may be justly appreciated, we beg leave, before stating our analysis of them, to offer to the Academy a summary sketch of our present knowledge in this branch.

We shall not go further back than to the labours of Drs. Gall and Spurzheim; since to do so would be of no use on the present occasion. Besides, this analysis has aleady been made, and indeed often with that rigorous justice which tends rather to rob a living discoverer than to enrich his predecessor.

It will doubtless be recollected that Gall and Spurzheim regard the spinal cord as consisting of ganglia, or masses of grey substance which they call nervous matter, corresponding in number to the principal vertebræ, and giving rise to the spinal nerves which in their size bear a proportion to the ganglia. Thus with them the superior bulbous extremity of the spinal cord is one of these ganglia giving origin to all the sensorial nerves, and also to two bundles of fibres, of which the upper, the corpus rectiforme, goes to form the cerebellum; and the inferior, the corpus pyramidale, the cerebrum. For this purpose these bundles are augmented by new fibres, which take their origin in the grey matter constituting the corpus dentatum or rhomboideum,

rhomboideum, for the cerebellum; and successively in the locus niger of Semmering, in the crus cerebri, in the thalamus opticus, and in the corpus striatum for the cerebrum. These are what they call the ganglia of reinforcement.

The numerous nerves which form the crura cerebri and cerebelli (and which they consider as being not less special with respect to the different parts of the hemispheres than the nerves belonging to the organs of the external senses are to them) are continued to the internal surface of the folded or convoluted membrane constituting the hemispheres of the cerebrum and cerebellum, and which is covered on its external surface with a layer of cineritious matter. From this latter substance arise other white or nervous fibres, which, differing from those before mentioned, pass from the circumference to the centre, and uniting with their fellows, on the median line, form for the cerebellum the pons Varolii; and for the brain the corpus callosum. These are the parts which Gall and Spurzheim call the commissures of the hemispheres in these organs.

One of us (Ducrotay de Blainville) has admitted in his general considerations on the nervous system, that the spinal cord is composed of two lateral columns, each of which consists of a principal part formed of white substance, and of grey matter, apparently internal, and of three longitudinal bundles: —one anterior or inferior, and two posterior or superior; of which one is deep, the other superficial. He has also stated that these two columns are united together anteriorly by a commissure of grey, and posteriorly by a commissure of white substance.

The views of Blainville differ from those of Gall and Spurzheim in this;—that he regards the spinal cord as continuous with all the parts of the brain, which organ he divides into a central part, and a ganglionic part with or without external apparatus. He considers that the central part begins to divide into two parts, where the fourth ventricle is formed by the separation of the two superficial posterior bundles, as they proceed onwards to the crura cerebri, which they contribute to form. The result of this he considers to be the uncovering or exposure of the internal cineritious matter, and the formation of the thalami and corpora striata, if these bodies are not rather to be looked upon as true cerebral convolutions. The larger fasciculi of the cord, or those in which the cineritious matter is lodged, directing themselves to the right and left as they advance to the formation of the crura. He even traces the central cineritious substance into the eminentiæ mammillares, and into the substance which closes the third ventricle anteriorly (the infundibulum). He traces this ven-

tricle from its commencement at the pituitary gland, following it to the right and left into the lateral ventricles, and through the aquaductus Sylvii, or iter a tertio ad quartum ventriculum, into the fourth ventricle, and finally through the whole length of the spinal marrow.

Examining next the ganglia without external apparatus; namely, the olfactory lobes, the hemispheres, the tubercula quadrigemina, the pineal gland, and the cerebellum,—he considers that each of these parts communicates more or less intimately with the central part to which it is attached through its peduncle or origin, consisting of ascending and descending fasciculi of fibres. He likewise considers that each lateral portion communicates with its fellow by a transverse commissure of medullary matter, that for the hemispheres being the corpus callosum, and that for the cerebellum being the pons Varolii.

He considers that the nerves which are called cerebral nerves communicate with the cephalic portion of the medulla, in the same manner as the spinal nerves do with the spinal portion, by means of two orders of fibrillæ, the one anterior, the other posterior; so that according to his view there are in the head only so many pairs of nerves as there are vertebræ, that is to say, that there are four.

Dr. Rolando, before the last of the authors whom we have cited, and as he himself asserts, before the first of them, had exposed the structure of the brain in a manner which it will be proper shortly to describe. His views, which it is not easy to understand, appear to us in many points to resemble those of Drs. Gall and Spurzheim. According to Rolando, the hemispheres are composed of numerous fibres, which proceeding from their crura ascend and diverge as they traverse a part of the cineritious matter composing the corpora striata. These fibres partly disperse themselves into the medullary matter composing the corpus callosum, the fornix, and the septum lucidum; whence on all sides medullary matter is spread in an extremely thinly extended form over that part of the corpora striata which projects into the ventricles; whilst another portion of the fibres turning backwards forms the two posterior pillars of the fornix, the cornua Ammonis, and the tails or narrow posterior extremities of the corpora striata. Whence it appears to him, that there are in fact no corpora striata or thalami optici, properly so called, but that these prominences are formed by the interlacing and passage,—1st, of the superior fibres of the crura cerebri; 2ndly, of those which appear to come from the hemispheres, and to be in relation with the corpora quadrigemina; and lastly, in the third place, of those which pass transversely, ascending and spreading themselves in the form

of

of a membrane over the thalami optici in the direction from within outwards, and which, afterwards uniting into a cord, pass round the crura cerebri, and having decussated, constitute the optic nerves.

We thought it required of us to give this exposition of the principal methods which have of late been proposed to make known the structure of the brain. Having done so, we will now proceed to analyse the memoir of Dr. Foville. [Believing that the Doctor's views will be best understood from his own explanation of them, I here insert the translation of his memoir; and to avoid needless repetition, I suppress that part of the report which merely consists of the epitome of the paper. —T. H.]

Researches on the Anatomy of the Brain, presented to the Royal Academy of Sciences of Paris, by Dr. Foville, *Ex-internal Elève of the Civil Hospitals of Paris; Principal Physician of the Lunatic Asylum for the Department of the Lower Seine, &c.*

Gentlemen,

During six years in which I was connected with the medical service of the hospitals of Paris, I had the privilege of being placed in immediate relation with those whose labours on the subject of the diseases of the brain have mainly contributed to the advancement of this branch of science. I endeavoured to profit by the advantages of my position, by imbibing their observations and making myself master of their doctrines.

For this object it was most essential to have recourse to that foundation, without which all medical theories vacillate on the brink of annihilation,—on anatomy, which has ever been most in arrear in that which relates to the structure of the brain.

It is true that very important observations had been made respecting the general development of the nervous system, and on its gradual complication in the scale of animals; and that anatomists are pretty well agreed as to its general composition. We are nevertheless ignorant of the structure of its principal parts; and the most widely received opinions with respect to them, are perhaps nothing more than ingenious hypotheses, which accurate observation may overthrow.

I saw that it was necessary that I should examine for myself. The first object of my researches was to verify accredited theories. Their first result was to inspire me with doubt respecting the validity of those theories. In the course of these researches I was struck with certain constant dispositions in the cerebral organization, which appeared to me to have been hitherto

hitherto unnoticed. I multiplied my observations, and found that the facility of making them was increased by daily practice; and I soon became sufficiently familiar with the details of structure which I had noticed, to be able clearly to demonstrate them.

It is three years since I laid before my preceptors and colleagues, for their opinion, the anatomical preparations of the brain, which I made in their presence. I was animated by the confidence which their united approbation excited.

About the same time I had the opportunity of soliciting the judgement of those whose whole career had been devoted to the study of this subject; and if they were not all decided in favour of my views, by the greater number, the preparations, on which these views were founded, were considered to be conclusive.

My Essay was presented to the Academy of Medicine; but in consequence of the death of Professor Beclard, who was appointed the reporter, the judgement of that learned Society has, down to the present time, been suspended. Notwithstanding the Academy of Medicine condescended not long after to award its prize to an extensive Essay on the functions and diseases of the nervous system, of which Essay my anatomical researches formed a part.

Although since that period I have been removed from the capital, in order to take the charge of the medical department of the noble institution for the insane at Rouen, I have not ceased to pursue my anatomical researches, which I am now occupied in describing.

Before sending my work to the press, the greatest favour to which I can aspire, and the most imposing title which I can covet as a claim to the confidence of the public, is unquestionably, the favourable decision of the Academy of Sciences. With the hope that the Academy will grant a few moments to the examination of my observations, I have requested to be allowed the honour of reading a summary of the facts which I flatter myself that I have proved.

Laying aside the historical examination of the subject, and taking up the science at the point to which I find it at present advanced, I shall in the first place say a few words respecting the spinal marrow, and shall afterwards describe in succession, what I have observed in the organization of the cerebellum, in the crura cerebri, in their expansion in the corpora striata, and thalami nervorum opticorum; and finally, I shall speak of the organization of the brain itself, and of its principal parts.

To these anatomical data I shall subjoin such physiological and pathological considerations as the subjects may elicit.

[To be continued.]

XLIV. *An*

XLIV. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from p. 195.]

Genus 43. EYPREPIA, *Ochs.**

Arctia, Schrank, Latr. Hypercompæ, Hübn.
Callimorpha et Lithosia, Latr.
Eyprepia, Eulepia, Spilosoma, Deiopeia, Curtis.
Arctia, Euthemonia, Nemeophila, Hypercompa, Phragmatobia, Diaphora, Spilosoma, Eulepia, Deiopeia. Stephens.

Antennæ bipectinate, or setose, and very slightly ciliated; cilia scarcely visible.
Wings deflexed.
Haustellum very short.
Abdomen spotted on the hinder part.
Larva with hairy tubercles on every segment of the body†.
Pupa robust; changes in a soft web, of unequal texture, above ground.
Obs. Ochsenheimer appears to have been as much too fearful of creating new genera, as many of our modern naturalists, not merely in entomology, are too fond of it. He has in this group, as in the last, adopted divisions into families, and also, except in one instance, given distinctive characters to each, but no *names*.—We are no friends to loading natural history with unnecessary words, but great groups like the present *must* be divided; and those divisions are better discriminated as genera, with appropriate names, than as families with the unmeaning A, B, C, &c. prefixed. All arrangement is artificial, and its great object is to assist the memory; and, therefore, well-chosen names are better than letters and asterisks; and system, by bringing together those subjects which have more or less resemblance to each other, impresses their forms and qualities more firmly on the mind, than the individuals could do, separately; as great masses strike the attention more forcibly than minute. But we should never forget that nature knows nothing of our systems; indispensable

* Ευπρεπεια, decor eximius.
† Hence called *Barenraupen—Larvæ ursinæ—Bear-Caterpillars.*

as

as they may be to us, they are altogether the offspring of our own imaginings, from the comparatively rude attempts of the earlier methodists, to the *Règne Animal* of Cuvier, or the *Horæ Entomologicæ* of W. S. Macleay. They are human, not divine systems; and however beautifully they may illustrate the apparently mutual connections and gradations in structure or habit amongst the countless multitude of beings that constitute the animal world, we have only our own assumption that any such gradations and connections really exist;—an assumption, however, far from rash or presumptuous, but, on the contrary, supported by the evident harmonies of nature. It is not, therefore, against such systems that we would object, but against their abuse; against the wild attempt to strain them beyond what their texture can bear; to make them, not the faithful guide and assistant to the student, but the laboratory note-book of the Great Author of Nature! Such, at least, is the almost blasphemous trash, published by a celebrated foreign naturalist, in an otherwise admirable work,—trash, of which it is difficult to say, whether it most deserves our execration, or our contempt! Infinite power, trying experiments! First making a monkey,—and then a man!! What *the greatest Naturalist of modern times* has recently said of Fish, is applicable, *mutatis mutandis*, to the whole of animated nature. "Les Poissons forment une classe d'animaux distincte de toutes les autres, et destinée en totalité par sa conformation à vivre, à se mouvoir, à exercer les actes essentiels à sa nature dans l'élément aqueux. C'est là leur place dans la création. *Ils y ont été dès leur origine; ils y resteront jusqu'à la destruction de l'ordre actuel des choses, et ce n'est que par de vaines spéculations métaphysiques, ou par des rapprochemens très-superficiels, que l'on a voulu considérer leur classe comme un développement, un perfectionnement, un annoblissement de celle des mollusques, ou comme une première ebauche, comme un état de fétus des autres classes des vertèbrés.*" — Cuvier, Hist. Nat. des Poissons. 4to. I. 401.

Had the author, against whom Cuvier's observations are obviously directed, been a Scotchman, we might have supposed he had stolen a hint for his precious hypothesis from the playful lines of Burns:—

> "Her 'prentice han
> She tried on man,
> And then she made the lassies, O!"

Fam. A*. *Antennæ* finely pectinated. *Wings*, *anterior* small, *posterior* broad: *body*, *back* smooth; *abdomen* slender at the hinder part, with black spots on the middle and sides.

Species.	Icon.
1. E. *Coscinia*, Ochs....	Hübn. Bomb. Tab. 58. f. 251. B.
2. — *Candida*, Cyril....	Hübn. Bomb. Tab. 28. f. 119. (fœm.)
3. — *Cribrum*, Linn.†	Ernst, VI. Pl. CCXX. f. 308. a. b. Curtis, Brit. Ent. II. pl. 56.
4. — *Pulchra*, Hübn.‡	Ernst, VI. Pl. CCXXI. f. 309. a—e. Curtis, Brit. Ent. IV. Pl. 169. (Imago et larva.)
5. — *Grammica*, Linn.	Ernst, IV. Pl. CLVI. f. 202. a—l.

Fam. B. *Antennæ* finely pectinated, or scarcely visibly ciliated. *Wings*, *anterior*, with white or yellow spots, on a dark ground; *posterior* red or yellow with black spots. *Abdomen*, hind part slender, red or yellow; generally with black transverse lines. *Flight* diurnal.

* Lithosia, Latr.

"*Palpi* (cylindrici) capite breviores, articulo tertio, sive ultimo secundo breviore, cylindrico. *Eruca* pedibus sexdecim, solitaria, nec cucullata, nec subcutanea."—*Latr. Gen. Crust. et Ins.* IV. 221.—Hoc genus in sectiones duas à Latreilli oscinditur; nempe, I. *Antennæ* masculorum *pectinatæ*. II. *Antennæ simplices vel tantummodo ciliatæ.*

† Eulepia, Curtis.

"*Antennæ* setaceous, composed of about 40 joints covered above with long scales, bipectinated in the *males*, pilose, each branch terminated by two bristles: simple in the *females*, with two bristles arising on both sides from each joint. *Labrum* and *mandibles* attached to the clypeus. *Maxillæ* short, broad, flat, not much longer than the head. *Labial palpi* 2, very short, sparingly clothed with scales: 2- or 3-jointed, 1st joint long, curved upwards, 2nd and 3rd short, of equal length. Head *rather small, thickly covered with hairy scales.* Wings *oblong, incumbent, convolute, inferior ones much folded.* Thighs *long and slender;* anterior tibiæ *short, with a large spine on the middle of the internal side,* 2nd *pair terminated by spurs; posterior with 2 pair of spurs.* Tarsi *5-jointed.* Claws *obscure.* *Pulvilli* distinct."—*Curtis, Brit. Ent.* II. Pl. 56.

‡ Deiopeia, Stephens.

"*Palpi* elongate, bent upwards, slightly clothed with scales, triarticulate, the basal joint stoutest, the second longest, the third short, ovate: *maxillæ* as long as the antennæ. *Antennæ* simple in both sexes, rather short, slightly hairy beneath in the males: *head* short, scaly: *wings* deflexed, *anterior* elongate, *posterior* broad, subdiaphanous, much folded; *body* subconic, stout, a little tufted in the male: *legs* moderate, *tibiæ* very short; *posterior* with two pair of spurs at the apex. *Larva* hairy: *pupa* folliculated."—*Steph. Illust. Brit. Ent. Haust.* II. p. 92.

Species.	Icon.
6. E. *Russula*, Linn.*...	Ernst, IV. Pl. CLV. f. 201. a—i. Curtis, Brit. Ent. Pl. 21. ♂ & ♀.
7. — *Plantaginis*, Linn.†	Ernst, IV. Pl. CXLV. f. 191. a—k. Pl. CXLVI. f. 191. l—u. Pl. CXLVII. f. 192. a—k.
8. — *Lapponica*, Thunb..	Hübn. Bomb. Tab. 57. f. 247. (mas.) Tab. 53. f. 230. (fœm.)

* Eyprepia, Curtis.

To the above slender materials for distinguishing a genus (for these A. B. C. families are in fact genera), I think the reader will thank me for adding the characters of Eyprepia, as given by Curtis, who includes under this genus three species; *Russula*, *Caja*, and *Villica*. Stephens does not adopt Eyprepia, but has created the genus Euthemonia to receive the present species, placing *Caja* and *Villica* under Schrank's genus Arctia, which he restores. "Ey. *Antennæ* setaceous, composed of many joints, covered with scales above, naked beneath, bipectinated and ciliated in the males, each branch having a bristle at its apex; rather serrated in the females, each serrature being terminated by a bristle. *Labrum* and *Mandibles* small and obscure. *Maxillæ* about the same length as the head, composed of two separate filaments, distant, broad and flat. *Labial palpi 2*, porrected, covered with long hairs, three-jointed. *Wings* trigonate, deflexed, undivided. *Anterior tibia* with a compressed spine in the centre of its internal side. *Caterpillars* hairy, with 16 feet."—*Curtis, Brit. Ent.* I. Pl. 21.

The genus Euthemonia (*ευθημων, concinnus*) is characterized by Stephens as follows:

"*Palpi* porrected, moderate, slightly hairy, triarticulate; the basal joint shorter than the second, the terminal rather slender: *maxillæ* short. *Antennæ* rather short, slender, bipectinated in the males, serrated in the females: *head* small, pilose: *thorax* and *abdomen* rather slender; the former hairy, the latter with a small tuft at the apex, and annulated: *wings* deflexed, densely squamous, trigonate: *legs* rather slender, the anterior with a compressed lobe on the inner edge, the posterior with spines at the apex: females smaller than the males. *Larva* with short, closely set fascicles of hair: *pupa* rather elongate, with a spine at the apex."—*Steph. Illust. Brit. Entom. Haust.* II. p. 68.

† Nemeophila, Steph.[a]

"*Palpi* extremely short, enveloped in the hairs of the front, triarticulate, the joints of nearly equal length, subglobose, the basal largest; the terminal smallest, and slightly compressed: *maxillæ* very short. *Antennæ* rather slightly bipectinated in the male, the pectinations shortening towards the apex, serrated and ciliated in the female: *head* small, very pilose: *thorax* and *abdomen* rather slender, the former with elongated hairs in the male, the latter stoutest and acute in the female, tufted at the apex in the male: *wings* deflexed, opaque, scaly: *legs* rather short: *anterior tibiæ* with a spine on the inside; *posterior* with spurs at the apex. *Larva* cylindric, slightly tuberculated, each tubercle producing a fascicle of hair: *pupa* with a truncate projection."—*Steph. Illust. Brit. Ent. Haustell.* II. p. 72.

[a] Νεμος *nemus*, Φιλος *amicus*.

9. E. *Do-*

Species.	Icon.
9. E. *Dominula*, Linn...*	Ernst, IV. Pl. CLII. f. 197. a—h.
10. — *Hera*, Linn.	Ernst, IV. Pl. CXLIV. f. 190. a—i.
11. — *Clymene*, Esper....	Hübn. Bomb. Tab. 31. f. 135. (fœm.)

Fam. C. *Antennæ* bipectinated: *wings*, *anterior* with white or yellow stripes or spots on a dark ground, or dark spots on a light ground; *posterior* red or yellow, with, frequently confluent, black spots: *head* and *back* very pilose: *abdomen* thick at the hinder part, with red, or yellow and black spots.

12. E. *Purpurea*, Linn.†	Ernst, IV. Pl. CLIII. f. 198. a—k.
13. — *Aulica*, Linn.†...	Ernst, IV. Pl. CXLIX. f. 195. b—f.
14. — *Curialis*, Borkh.	Ernst, IV. Suppl. Cl. Ire. f. 195. a—f. bis.
15. — *Matronula*, Linn.†	Ernst, IV. Pl. CXLVIII. f. 194. a—e. Pl. CXLIX. f. 194. f—h.
16. — *Villica*, Linn.† ...	Ernst, IV. Pl. CL. f. 196. a—g. Pl. CLI. f. 196. h—o.
17. — *Fasciata*, Esp.....	Ernst, IV. Pl. III. Suppl. Cl. Ire. f. 187. a—d. bis.
18. — *Pudica*, Fab.....	Ernst, IV. Pl. CXLVIII. f. 193.
19. — *Caja*, Linn.†	Ernst, IV. Pl. CXXXIX. f. 187. a—h. Pl. CXL. f. 187. i—q. Pl. CXLI. f. 187. r—y. Pl. CXLII. f. 187. aa—ff.
20. — *Flavia*, Fab.	Ernst, IV. Pl. CXLII. f. 188. a. b.
21. — *Hebe*, Linn.†.. ...	Ernst, IV. Pl. CXLIII. f. 189. a—k.

Fam.

* Hypercompa, Hübn.? Steph.

"*Palpi* very short, ascending, pilose, triarticulate, the terminal joint exposed; the basal joint tumid at the apex, as long as the second, terminal short, ovate: *maxillæ* considerably longer than the head. *Antennæ* simple, ciliated in both sexes: *head* small, clothed with short, compact hair: *thorax* and *abdomen* not very stout, covered with close, short, velvety pile: *wings* deflexed, densely squamous; the anterior elongate-trigonate: *legs* robust, squamous. *Larva* with fascicles of hairs down the sides: *pupa* smooth, with a spine at the apex, inclosed in a loose web on the ground."—*Steph. Illust. Brit. Ent. Haust.* II. p. 67.

Both sexes, Stephens adds, of Hypercompa, are remarkable for having the antennæ simple and ciliated, and are readily distinguished from all the other Arctiidæ by their elongated maxillæ, which are much longer than the head, and spirally, but irregularly twisted.—*Steph. l. c.*

† Arctia, Schrank, Steph.

"*Palpi* porrected, short, very hairy, triarticulate, the basal joint longer

Species.	Icon.
Fam. D. 22. E. *Casta*. Fab. ...	Hübn. Bomb. Tab. 31. f. 137. (fœm.) Tab. 51. f. 219. (mas.)
23. — *Maculosa*, Fab. ...	Ernst, IV. Pl. CLIV. f. 199. a—h.
24. — *Parasita*, Hübn.	Hübn. Bomb. Tab. 33. f. 146. (mas.) Tab. 53. f. 228. (fœm.)
25. — *Fuliginosa*, Linn.*	Ernst, IV. Pl. CLIV. f. 200. a—e. Pl. CLV. f. 200. f—h.
26. — *Luctifera*, Fab. ...	Ernst, IV. Pl. CLIX. f. 206. a—d. Pl. CLX. f. 206. e—g.
27. — *Ciliaris*, Ochs. ...	Hübn. Bomb. Tab. 51. f. 216. (mas.)

than the second, the terminal ovate, or cylindric: *maxillæ* short. *Antennæ* rather long, slender, bipectinated in the males, serrated in the females, the serrations and pectinations terminated by a fine bristle: *head* small, pilose: *thorax* stout, densely pilose: *abdomen* robust, tufted at the apex in both sexes, transversely streaked or spotted: *wings* deflexed, densely scaly, elongate-trigonate: *legs* short, *femora* very pilose: *anterior tibiæ* with a compressed lobe. *Larvæ* solitary, cylindric, thickly clothed with elongate fascicles of hair, each fascicle arising from a tubercle; when touched roll themselves into a ring: *pupa* rather elongate, with a spine at the apex, inclosed in a loose, extended web; eggs naked, deposited with regularity."—*Steph. Illust. Brit. Ent. Haust.* II. p. 69.

The colours of the Arctiæ, Stephens adds, are lively and brilliant, and the individuals of this genus are distinguished from those of the genera Euthemonia, and Nemeophila, by their robust thorax and abdomen, and the transverse stripes, or longitudinal spots of the latter; they have also the basal joint of the palpi longer than the second, and the antennæ rather elongated.—*Steph. l. c.*

* Phragmatobia[a], Steph.

" *Palpi* short, very hairy, triarticulate, the basal joint the length of the second, and stouter; the terminal shortest, and ovate, obtuse: *maxillæ* rather spiral. *Antennæ* short, serrated, simple in the female, ciliated in both sexes: *head* very small, pilose: *thorax* stout, woolly: *abdomen* rather stout in both sexes, tufted at the apex in the males, acute and smooth in the females: *wings* deflexed, subdiaphanous; the *anterior* elongate, trigonate: *legs* stout: *anterior tibiæ* with a spine internally; two posterior pair with spurs at the apex. *Larva* very hairy: *pupa* with a slight spine, folliculated."

" The abbreviated nearly simple antennæ in both sexes, robust thorax and abdomen, the latter spotted, and semi-transparent elongate, triangular wings, well distinguish this genus; to these may be added the characters of the palpi, which have the basal joint as long as the second, and stouter, with the terminal very short and ovate."—*Steph. Illust. Brit. Ent. Haust.* II. p. 73.

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[a] Φραγμος sepes, βιοω vivo.

Fam.

Fam. E. *Antennæ* pectinate, pectinations short: *wings* white or yellow, with black spots: *legs*, *femora* of the *anterior* yellow: colour of the *back* and *abdomen* simple, or the latter yellow with five rows of black spots; *back* hairy.

Species.	Icon.
28. E. *Mendica*, Linn.*	Ernst, IV. Pl. CLIX. f. 205. a—h.
29. — *Rustica*, Hübn.?	— — —
30. — *Menthastri*, Fab.†	Ernst, IV. Pl. CLVII. f. 204. a—c. Pl. CLVIII. f. 204. d—k.
31. — *Urticæ*, Esp.†	Ernst, IV. Pl. CLVIII. f. 204. m—n.
32. — *Lubricipeda*, Linn.†	Ernst, IV. Pl. CLVII. f. 203. a—g.

* Diaphora[a], Steph.

"*Palpi* moderate, descending, triarticulate, the two basal joints very hairy, the terminal squamous, all of nearly equal length, cylindric, the basal one incurved, the terminal more slender than the others, obtuse: *maxillæ* rather longer than the head. *Antennæ* bipectinated in the males, serrated in the females, the pectinations incurved, and meeting at the apex: *head* very small, woolly: *thorax* stout, very woolly: *abdomen* slender in the male, robust and slightly acute in the female: *wings* subdiaphanous, deflexed, trigonate: *legs* short, stout; the *anterior tibiæ* short, with a spine on the inside, the *posterior* with spurs at the apex. *Larva* tuberculated, each tubercle producing a tuft of hairs: *pupa* acute, folliculated."— *Steph. Illust. Brit. Ent. Haust.* II. p. 77.

† Spilosoma[b], Steph.

"*Palpi* short, a little descending, triarticulate, the two basal joints very hairy, the terminal scaly, the basal joint somewhat longer than the second, the apical rather small, oval, subconic: *maxillæ* short. *Antennæ* slightly bipectinated in the males, serrated in the females, each articulation with a bristle at the apex: *head* rather small, hairy: *thorax* and *abdomen* stout in both sexes, the latter slightly tufted in the male, acute in the female; *wings* trigonate, deflexed, opaque: *legs* moderately stout: *anterior tibiæ* short, with a spine internally: the *four posterior* with spurs at the apex. *Larva* slightly tuberculated, each tubercle producing a whisker of hairs: *pupa* obtuse, folliculated."— *Steph. Illust. Brit. Ent. Haust.* II. p. 74.

The predominant colour of this group is white, the wings deeply speckled with black, and the body spotted with the same colour, in longitudinal lines. Curtis adopts this genus from Stephens's MSS., and quotes as belonging to it the following British species:

1. Spilosoma lubricipeda, *Linn.*—*Don.* Vol. xvi. pl. 568.
2. ——— Walkerii. *Curtis.* Vol. ii. pl. 92.
3. ——— Menthastri, *Fabr.*—Linn. Trans. I. p. 70. (Erminea. *Marsh.*)
4. ——— Urticæ, *Hübn.*
5. ——— papyritia. *Marsh.*—Linn. Trans. I. p. 70.
6. ——— radiata, *Haw.* MSS.

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[a] Διαφορα, *differentia.*

[b] Σπιλος *macula*, σωμα *corpus.*

Genus

Genus 44. ACRONYCTA, *Ochs.*, *Treitschke.*

Apatelæ, Hübn.

Antennæ inserted on the crown of the head, close to the eyes, alike in both sexes, long, setaceous, composed of numerous joints covered with scales above, basal joint tufted with scales, forming a cup for the insertion of the second.

Maxillæ as long as the antennæ, with tentacula towards the apex.

Labial palpi porrected obliquely, completely clothed with rather short scales, the terminal joint being very distinct; three-jointed, basal joint robust, second long, linear, third short, ovate.

Head subtrigonate. *Thorax* subquadrate, clothed with rather long and large scales. *Abdomen* large, robust, angulated, obtuse, and having a margin of scales in the males; cylindro-conical in the females.

Wings deflexed when at rest; superior rather elongate-lanceolate; inferior rather small.

Legs, anterior the shortest: *tibiæ*, anterior much shorter than the tarsus, with a twisted, subulated spine on the internal side, the others spurred at the apex, the posterior having a pair above, on the side: *tarsi* five-jointed, basal joint the longest: *claws* simple: *pulvilli* distinct.

Larvæ various, with six pectoral, eight abdominal, and two anal feet *.

Fam. A. *Larva* hairy; no tubercles on the back.

Species.	Icon.
1. A. *Leporina*, Linn.	Ernst, VI. Pl. CCXVI. f. 296. b. d. e.—f. 297. a. b.
2. — *Bradyporina*, Treit.	Ernst, VI. Pl. CCXVI. f. 296. c.
3. — *Aceris*, Linn.	Ernst, VI. Pl. CCXVI. f. 295.
4. — *Megacephala*, Fab.	Ernst, VI. Pl. CCXV. f. 294.
5. — *Alni*, Linn.	Ernst, VI. Pl. CCLIV. f. 386.
6. — *Ligustri*, Fab. ...	Ernst, VI. Pl. CCXXV. f. 320.
7. — *Strigosa*, Fab. ...	Ernst, VI. Pl. CCXI. f. 285.
8. — *Tridens*, Fab. ...	Ernst, VI. Pl. CCXII. f. 287. a. b. c. e.
9. — *Psi*, Linn.....	Ernst, VI. Pl. CCXII. f. 286.
10. — *Cuspis*, Hübn. ...	Ernst, VI. Pl. CCXII. f. 287. d. f.
11. — *Menyanthidis*, Hübn.	Hübn. Noct. Tab. 2. fig. 6. (mas.) f. 7. (fœm.)

* Generic Characters from Curtis.

12. A. *Auri-*

Species.	Icon.
12. A. *Auricoma*, Fab. ...	Ernst, VI. Pl. CCXIII. f. 289.
13. — *Rumicis*, Linn. ...	Ernst, VI. CCXIII. f. 288.
14. — *Euphorbiæ*, Fab.	Hübn. Noct. Tab. 3. fig. 12. (fœm.) Tab. 114. f. 529. (mas.)
15. — *Salicis**, Curtis....	Curtis, Brit. Ent. III. Pl. 136.
16. — *Euphrasiæ*, Borkh.	Hübn. Noct. Tab. 134. f. 613.

Genus 45. DIPHTHERA, *Ochs.*

Diphtheræ, Hübn.

Wings deflexed; *anterior* spotted.
Body, posteriorly spotted; *back* gibbous.
Larva variegated, hairy; hairs long and thinly set: (much resembling those of the genus Liparis.)
Pupa, changes in a close web above ground †.
Palpi very short.—*Godart, Duponch.*
Antennæ filiform in both sexes ‡. *Godart, Duponch.*

Species.	Icon.
1. D. *Cœnobita*, Hübn.	Ernst, IV. Pl. CXXXVI. f. 184.
2. — *Ludifica*, Linn. ...	Ernst, VI. Pl. CCXXVI. f. 323.
3. — *Orion*, Esper.....	Ernst, VI. Pl. CCXXVII. f. 325.

Genus 46. BRYOPHILA, *Ochs., Treitsch.*

Pœcilia, Schrank., Ochs. Jaspidia, Hübn. §

Wings, deflexed when at rest.
Antennæ filiform.
Body, posteriorly rugose.
Larva gregarious.

Fam.

* Not in Treitschke's continuation of Ochsenheimer: usually confounded with *A. Euphorbiæ*. (C.)

† The above are all the characters given by M. Treitschke as *generic*, whereby to distinguish the Diphtheræ!

‡ This applies only to *D. ludifica*, and *Orion:* in D. Cœnobita the antennæ of the male, according to Duponchel, is bipectinated; those of the female, filiform.

§ In his sketch of the Genera, in the 4th volume, Ochsenheimer has announced a genus by the name of Colocasia, to receive two species, *B. Coryli*, Linn. and *Geographica*, Fab. (*B. Sericina*, Hübn.) which his successor M. Treitschke has rejected, referring the first species to the genus Orgyia, and the second to that of Gastropacha. Mr. Stephens seems to differ from M. Treitschke in his idea that these two species should not form a distinct genus, and accordingly he adopts Ochsenheimer's views: "the crested thorax at once distinguishing this genus from the other Arctiidæ, and its subspiral maxillæ from 'Dasychira, Psilura,' &c.; from which it also differs by the

Fam. A.—*Wings* rounded; generally of a light-greenish colour.

Species.	Icon.
1. B. *Glandifera*, Hübn.	Ernst, VI. Pl. CCXXVI. f. 322.
2. — *Par*, Hübn.	Hübn. Noct. Tab. 110. fig. 515. (mas.)
3. — *Perla*, Hübn. ...	Ernst, VI. Pl. CCXXV. f. 321.

Fam. B.—*Wings* elongated, small, marbled on a brown ground.

4. B. *Spoliatricula*, Hübn.	Ernst, VI. Pl. CCXXVII. f. 324.
5. — *Ereptripula*, Hübn.	Hübn. Noct. Tab. 6. f. 26. (fœm.)
6. — *Receptricula*, Hübn.	Hübn. Noct. Tab. 6. f. 27. (mas.)
7. — *Fraudatricula*, Hübn.	Ernst, VI. Pl. CCXXIV. f. 316.
8. — *Raptricula*, Hübn.	Ernst, VI. Pl. CCXXIV. f. 317.
9. — *Deceptricula*, Hübn.	Hübn. Noct. Tab. 6. f. 30. (fœm.)
10. — *Chalcedonia*, Hübn.	Hübn. Noct. Tab. 86. f. 404. (mas.)

the more slightly pectinated antennæ of the males, and simply ciliated antennæ of the females."—In adopting Ochsenheimer's views, however, Stephens does not adopt his generic name; Colocasia being employed in botany, he has chosen that of Demas[a] in its stead.

Demas, Steph.

"*Palpi* extremely short, enveloped in hair, triarticulate, the basal joints rather stoutest, the second nearly as long again as the preceding, the terminal minute, ovate: *maxillæ* short, a little spiral. *Antennæ* rather elongate, acute, slightly bipectinated in the males, ciliated in the females: *head* small, pilose: *thorax* stout, crested: *abdomen* moderately stout, the back with hairy fasciculi; the apex with a tuft: *wings* deflexed, elongate, densely squamous: *legs* moderate; *femora* and *tibiæ* pilose; the anterior with a large, naked, lobate appendage anteriorly. *Larva* hairy, with two dorsal tufts, whiskers at the head, and a fascicle of hair at the tail: *pupa* smooth, with an acute termination posteriorly: changes in an ovate cocoon."—*Steph. Illust. Brit. Ent. Haustell.* II. p. 59.

1. D. *Coryli*, Linn..... Albin's Ins. Pl. 90. Don. IX. Pl. 309.

2. — *Geographica*, Fab.
N. cristata, alis deflexis fusco variis: strigis duabus posticè coëuntibus niveis, apice striatis.—*Fab. Ent. Syst.* III. b. 91. p. 271.

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[a] Δημας, *nomen viri.*

[To be continued.]

XLV. *Notices*

XLV. *Notices respecting New Books.*

Records of Mining. Edited by JOHN TAYLOR, *F.R.S. &c.*

THERE has been no work published which relates specially to mining, in the English language, since the Treatise by Dr. Pryce, of Redruth, in 1778, and his book must now be esteemed as more curious than useful. There are a few detached papers in the transactions of some of our learned societies; and these comprise all that is to be found on this subject in the literature of this country.

By the tables of produce given in the work under our consideration, we observe that the quantity of the soft metals raised in Great Britain in a year, may be computed at the following large quantities: copper 12,635 tons; lead 47,000 tons; and tin 5316 tons, implying, as we should suppose, the application not only of a large amount of capital, but also of sufficient skill, energy and experience to render capital itself productive to so great an extent.

We have often been struck with the difference of rank which is assigned to the art of mining, and to its professors, in foreign countries and in England. There, the art is valued as one most imporant to the state, and respected as requiring certain experience in a most difficult pursuit, and demanding considerable attainments in science: and those who direct its application, enjoy privileges and titles of distinction.

Here, mining is held to be a pursuit barely reputable; to be somewhat allied to gambling, to resemble a lottery in which are many blanks and few prizes, the whole dependent upon chance, and therefore the proper business of speculators and shallow projectors.

Now how does it happen that as the mines of England produce a value ten times as large as those of all the German States, such a different estimate should be made of the efforts that lead to such a result? Our answer would be, that there is in this country but little knowledge diffused upon the subject, and that in others there is a great deal. For want of information, a narrow view is taken of the whole; and in the absence of the just standard, by which a due measurement may be taken, empiricism is confounded with experience, pretence is mistaken for judgement, and the results of chance pass for those of skill. There is much in mining to favour such delusions: it is a work of experiment; it encounters the greatest difficulties, and deals in many uncertainties; and thus its most intelligent practitioners, like those of another uncertain though most useful art, may sometimes be outdone by an ignorant quack. We believe, however, that the tendency of mankind towards quackery of all kinds is most easily dispelled by the progress of information; and as the subject of mining includes the consideration of many interesting branches of science, and relates to an important part of productive industry, it can hardly be deemed unworthy of investigation.

Such a work as we have now before us, may effect a great deal in the communication of knowledge on subjects connected with

mining. It is a collection of papers or treatises contributed by different writers; and if continued, as we presume it is intended it should be, and the matter selected with judgement, it may form a valuable record of many interesting facts and observations, which must be constantly occurring, but which pass unnoticed, and are buried with those who witness them, for want of a place to register them for general use and advantage.

The first paper is by the Editor, and is a proposal for establishing a School of Mines in Cornwall, with suitable Professors for teaching the sciences necessary to those who conduct the practical details. It is rather surprising that in this educating age, and in a country where Mechanics' Institutes flourish so much, nothing should ever have been done for those who seem most to require this kind of assistance; while institutions for this purpose have long ago been thought to be essential in other countries.

Two treatises by J. H. Vivian, Esq. F.R.S. follow. The first relates to the celebrated process of amalgamating silver ores practised at Freyberg, in Saxony; and the second, to the modes of smelting silver ores in different parts of Germany. These papers are stated by the author to be intended to assist such of his countrymen as may be engaged in the mines of America, to whom they will be extremely interesting, and particularly the latter. The defects of the methods at present in use in Mexico for the reduction of the ores are becoming daily more apparent, and the necessity of improvement is more and more obvious. There is no practical experience on this subject in England; and although a difficult art cannot be taught in a treatise of this kind, yet Mr. Vivian has conferred a great benefit on those who are interested in the subject, by a concise and luminous account of such processes as are most in esteem in the countries where much attention has been given to this branch of metallurgy. The paper is illustrated by engravings of a very judicious selection of furnaces and apparatus best adapted for the purpose.

The next paper, by the Editor, describes the arrangements of pumps now employed in the largest English mines, and particularly points out the use of that construction which, in Cornwall, has obtained the name of *plunger*. This is in fact a forcing pump, in which the column of water is made to ascend by the descent of a solid cylinder, working through a stuffing-box into an appropriate barrel or case. The advantages of this arrangement are pointed out; and the importance of perfect hydraulic machinery is very evident, when the quantity of water and the depths from which it is to be raised are such as the author mentions in this treatise.

The next paper is also by Mr. Taylor, and relates to a subject very interesting to all engineers, and one on which some controversy has taken place;—the duty of steam-engines, and the amount of improvement which has at various times taken place in these most important machines.

This improvement has of late been stated to be so rapid in some of the engines employed in the mines in Cornwall, that it has occasioned

casioned considerable doubt as to the accuracy of the observations, or of the methods by which it has been determined.

Mr. Taylor, as may be expected, defends the statements which come from a quarter in which he is so much engaged. He has taken a historical survey of the evidence upon this subject, from a very early period, and compared the account given by Smeaton of atmospheric engines as they were in 1765, with others in the time of Boulton and Watt, and again with those most recently improved. The result is curious, if it be correct;—that as much power is now obtained from one bushel of coal, as in the earliest periods was to be had from seventeen bushels.

The mode of estimating the *duty* of steam-engines is explained, and a reference is made to the accounts which have been regularly published in Cornwall since the year 1813, of which an abstract in the form of a table is given, showing the average duty reported in each year of all the engines working, and the average duty of the best engines at each period.

From this table we extract the following results:

Years.	Engines working.	Average duty of the whole.	Average duty of the best Engines.
1813.	24	19,456,000	26,400,000
1828.	54	37,100,000	76,763,000

If this can be shown to be correct, there can be no doubt but that improvement in this as well as in other things has been progressive. Mr. Taylor supports the authority of these reports, by some statements exhibiting the diminished consumption of coal, in mines in which the water lifted is the same as formerly, and where the depth has been increased. This is a fair way of coming to the proof, and the facts must speak for themselves.

The work also contains tables of the produce of the mines of copper, tin, and lead, in Great Britain, with an account of the prices of the former for several years, and an estimate of the home consumption and export of those metals.

We should be glad to see statistical accounts of this kind more attended to by the miners in this country;—in other states they are regularly collected and published: we believe that it is difficult here to obtain them accurately; but we would recommend the Editor to extend his inquiries upon this subject. The iron made in England is supposed to be near 600,000 tons in a year; and several other metallic products come from our mines. We believe that 100,000 ounces of silver are extracted annually from our lead; and we have also a considerable quantity of manganese, besides zinc and antimony.

If persons in various mining districts would contribute information on this and various other interesting points, the "Records of Mining" could not fail to advance the progress of useful knowledge. The work is illustrated by many plates, some of which are beautiful specimens of the state of the arts of drawing and engraving, as applied to mechanical subjects.

XLVI. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

TO bring up our arrear of proceedings, we refer back to the 20th of November 1828, when a paper was read, intitled, "An Account of some experiments on the Torpedo," by Sir Humphry Davy, Bart., F.R.S., &c.

The author, after noticing the peculiarities discovered by Walsh in the electricity of the torpedo, and the opinion of Cavendish that it resembles the action of an electrical battery weakly charged, adverts to the conjecture of Volta, who considered it as similar to that of the galvanic pile. Being on the coast of the Mediterranean in 1814 and 1815, the author, desirous of ascertaining the justness of Volta's comparison, passed the shocks given by living torpedos through the interrupted circuit made by silver wire through water, but could not perceive the slightest decomposition of that fluid; the same shocks made to pass through a fine silver wire, less than one-thousandth of an inch in diameter, did not produce ignition. Volta, to whom the author communicated the result of these experiments, considers the condition of the organs of the torpedo to be best represented by a pile of which the fluid substance was a very imperfect conductor, such as honey, and which, though it communicated weak shocks, yet did not decompose water.

The author also ascertained that the electrical shocks of the torpedo, even when powerful, produced no sensible effect on an extremely delicate magnetic electrometer. He explains these negative results, by supposing that the motion of the electricity in the torpedinal organ is in no measurable time, and wants that continuity of current requisite for the production of magnetici effect.

Nov. 27.—A paper was read, intitled, "A Descripton of a Microscopic Doublet," by W. H. Wollaston, M.D., V.P.R.S.

The author, considering that in all microscopes distinct vision is impeded instead of being assisted by whatever light may be thrown upon the object beyond what is fully commanded by the object-glass, obviates this evil by collecting the admitted light to a focus in the same as the object to be examined. For this purpose he employs a plane mirror to direct the light, and a plano-convex lens to collect it; the plane side of the lens being towards the object to be illuminated. Availing himself of the property possessed by that form of eye-piece for astronomical telescopes called the Huygenian, of correcting both chromatic and spherical aberration, the author conceived that, by applying to a microscope the same combination reversed, he might obtain similar advantages. The construction he employed resembles two thimbles fitted one within the other by screwing, and with a perforation at the extremity of each. In these perforations are fixed two suitable plano-convex lenses, which may thus have their axes easily brought into the same line by means of their plane surfaces, while their distance from each other may be adjusted by screwing, so as to produce the best effect of which they

are

are capable. The best relative proportion of the foci of the two lenses appears, from the trials made by the author, to be that of three to one. The distances between their plane surfaces should in general be about 1·4 of the shorter focus, but should be varied by trial till the utmost possible degree of distinctness has been attained. The lenses must be fixed in their cells with their plane sides next to the object to be viewed. The exterior cell of the compound magnifier should be formed with a flanch, so that it may rest upon the piece that receives it. The plano-convex lens by which the object is illuminated is inclosed in a tube about six inches long, blackened in the inside, and having a circular perforation below of about three-tenths of an inch in diameter, for limiting the light reflected from the plane mirror. The centre of this aperture must be in the common axis of the lenses; and the image of the perforation formed by the large lens must be brought, by proper adjustment of the distance of that lens, into the same plane as the object to be examined. With a microscope so constructed, the author has seen the finest striæ and serratures upon the scales of the lepisma and podura, and the scales upon a gnat's wing, with a degree of delicate perspicuity not attainable with any other microscope he has tried. In consequence of the plane surface of the lens being next to the object viewed, the microscope of Dr. Wollaston possesses the important advantage of having its action undisturbed by the contact of a fluid under examination.

A paper was also read, intitled, "On the Stability of Canoes," by W. Walker Master, R.N.; communicated by the President.

The author having, in a former paper, endeavoured to show that the longitudinal axis on which a ship rolls, by the force of the wind on her sails, does not pass through the common centre of gravity, but always coincides with the plane of flotation, proceeds, in the present memoir, to the demonstration of his second proposition, namely, that the stability of a floating body is a maximum when the part immersed in the fluid is equal to half its magnitude; or, which is the same thing, when its total weight is half that of the fluid which it would displace by complete submersion. For this purpose he investigates the case of a canoe, supposed to have no stability in itself, and connected by an outrigger with a balance-boat at a certain distance; and shows that the power of such a boat in preventing the oversetting of the canoe, by the action of a horizontal force applied to the sails, is greatest when its weight is exactly the half of that of an equal volume of the fluid. Boats with outriggers, he observes, are admirably adapted for velocity, for they are enabled to carry a press of sail without ballast; they displace little water, and they move near the surface, where the resistance is less than at a greater depth. The application of a ballast-boat by an outrigger has, however, the disadvantage of tending to turn the prow of the canoe towards the wind; an inconvenience which the experienced Indian obviates by constructing his canoe with one side nearly a plane, so that the oblique influence of the fluid on the prow is balanced by the resistance of the boat; and the flat side of the canoe being always turned

turned to leeward, presents great resistance to lee-way, and very little to going a-head.

The author then notices the case of a double canoe, or one composed of two equal and similar canoes joined together by one common deck, and shows that the same general proposition respecting the conditions of the maximum of stability applies to the double as well as to the single canoe.

Dec. 11.—"Experiments to determine the difference in the lengths of the seconds pendulum in the Royal Observatory at Greenwich, and in Mr. Browne's house in London, in which Capt. Kater's experiments were made," by Capt. E. Sabine, of the Royal Artillery, Sec. R.S.

The experiments, of which an account is given in this paper, were made in compliance with a request of the Council of the Royal Society, in December 1827, that Capt. Sabine would ascertain the difference in the number of vibrations of a pendulum at Mr. Browne's house, and at the Greenwich Observatory. The author gives a description of the instruments used in the observations; the first series of which were made in Mr. Browne's house, from the 17th to the 20th of March inclusive, and gave as the mean result 859738·38 vibrations in a mean solar day. A reduction is here introduced, derived from some experiments made on the difference which takes place in the times of vibration *in vacuo*, and in the air: the number of vibrations in the former case being, under the same circumstances as in the observations, 9·62 *per diem* less than in the latter. A corresponding series made at Greenwich in May, gave as the mean result 85973·93 vibrations, thus indicating an acceleration of 0·55 parts of a vibration *per diem*. But the differences of latitude and of height between the two stations would have led us from theory to expect a total retardation of 0·38 parts of a vibration in the same time. From a second set of observations at Greenwich, the diurnal acceleration appeared to be 0·52 parts of a vibration. Taking the mean of this and the former result, it appears that the total amount of the discordance between theory and experiment is 0·91 parts of a vibration *per diem*. The stations are conveniently situated for verifying the existence of this anomaly; and its magnitude is such as to preclude all uncertainty as to its existence. With regard to its cause, the author is confirmed in the opinions he formerly entertained on this subject.

Tables are subjoined, containing accounts of the rate of the clocks used at both stations, and of the particulars of each series of observations.

Jan. 8.—A paper was read, intitled, "On the dip of the magnetic needle in London, in August 1828;" by Capt. Edward Sabine, of the Royal Artillery, Sec. R.S.

This paper commences by noticing, that the Philosophical Transactions contain the record of observations on the dip of the needle in London from the early part of the last century to the present time: that these observations all concur in showing a progressive decrease of the dip during the whole period in question; but that they

they are insufficient in number and frequency, and, the earlier ones particularly, in the required accuracy, to enable us to determine whether the annual decrease has been uniform or otherwise.

The author having taken much pains to obtain a correct determination of the dip in the Regent's Park in August 1821 (published in the Philosophical Transactions for 1822), repeated his observations in August 1828, at the expiration of seven years from the former determination,—an interval which he considered sufficient to throw light on the rate at which the dip is at present diminishing. In consequence of the increase of buildings in the Regent's Park, he was induced to change the place of observation to the Horticultural Society's garden at Chiswick: the distance apart is about five miles, but the direction is as nearly as possible that of the line of equal dip.

The apparatus, modes of observing, and needles employed, are fully described. The needles were four in number—one of the ordinary construction; a second fitted with Professor Meyer's apparatus for avoiding the errors arising from the non-coincidence of the centres of gravity and motion; a third, having a cross of wires attached to the axis, on the well-known plan of Dr. Mitchell; and a fourth, devised by Mr. Dollond, the middle of which is a cube perforated at right angles, so that the axis may be inserted in eight different ways.

In addition to his own apparatus and needles, the author obtained from the Colonial Department the use of a smaller apparatus, with a needle on Professor Meyer's plan, the same which was used by Capt. Franklin on his last land expedition. The observations with this apparatus were made by Mr. David Douglas, of the Horticultural Society. The results were as follow:—

With the ordinary needle	69° 46·1
With Meyer's needle	69 47·4
With the needle having an adjustable axis	69 38·3
With Mr. Dollond's needle	69 51·7
With the smaller apparatus	69 51·4
Dip in London in August 1828	69 47 N.

From the observations of 1821 and 1828, the author finds a decrease in the dip in London of 17′·5 in seven years, or an annual decrease of 2′·5.

The average annual decrease for the century preceding 1821 appears, from the most authentic observations, to have exceeded 3′. On examining the series of observations made on the dip in Paris since 1798, by MM. Humboldt, Gay Lussac, and Arago, the author finds a corresponding indication of a recent diminution in the yearly decrease of the dip; it appearing, by those observations, that the average yearly decrease in the first half of the period between 1798 and 1828 exceeded 4′·75, and in the second half fell short of 3′. He concludes by remarking that a repetition of the observations in London, at the expiration of another seven years, and a continuation of those at Paris, will probably afford a decisive indication on this point; and

notices,

notices, in case the annual change shall prove to be diminishing in this part of the world, the importance of determining the precise period at which the dip shall become stationary, and the minimum to which it shall then have arrived.

Jan. 15.—"Observations relating to the Function of Digestion." By A. P. W. Philip, M.D. F.R.S., &c.—The author, referring to his former papers, published in the Phil. Trans. concludes, that digestion requires for its due performance, both a proper supply of gastric secretion, and a certain muscular action in the stomach; the latter circumstance being needful for the expulsion of that portion of food which has been acted upon by the gastric juice. Nervous power is necessary for secretion; but the muscular action of the stomach being excited by the mechanical stimulus of the contents of that organ, is independent of the nervous power. It had already been shown by the author, that after the removal of a portion of the eighth pair of nerves, the galvanic influence directed through these nerves will restore the secretion of gastric juice. But Messrs. Breschet and H. Milne Edwards have lately endeavoured to prove that the same effect results also from mechanical irritation of the lower portions of the divided nerves. The author points out several circumstances which appear to have been overlooked by these gentlemen, and which he thinks invalidate the conclusions they have deduced from their experiments. He states that a certain quantity of digested food will always be found in the stomach of the animal for five or six hours after the operation, and even after the lapse of ten or twelve hours, from its being less completely changed, and therefore expelled more slowly than in the natural state. The paper concluded with the recital of experiments made for the author by Mr. Cutler, in which the contents of the stomach of a rabbit, whose eighth pair of nerves, after excision, had been kept mechanically irritated, were compared with those of another rabbit in which the nerves had not been irritated, and of a third which had been left undisturbed. All those who witnessed the result of this experiment, among whom was Mr. Brodie, were convinced that the irritation of the nerves had no effect whatever in promoting the digestion of the food, neither did it at all contribute to relieve the difficulty of breathing consequent upon the section of the nerves.

Jan. 29.—A paper was read "On a definite Arrangement, and Order of the Appearance and Progress of the Aurora Borealis; and On its Height above the Surface of the Earth;" by the Rev. James Farquharson, minister of the parish of Alford, in Aberdeenshire. Communicated by the President.

The results of the numerous observations of the author on the aurora borealis, which on several occasions were made under very favourable circumstances, had already been announced in a short paper published in 1823 in the Edinburgh Philosophical Journal; and it was concluded from them that the aurora borealis has in all cases a determinate arrangement and figure, and follows an invariable order in its appearance and progress; that the pencils of rays

or

or streamers, as they are called, generally make their first appearance in the north, and as they rise from the horizon assume the form of an arch, extending from east to west, and having its vertex in the plane of the magnetic meridian; the arch itself being at right angles to the plane. While the arch is near the horizon, its breadth from north to south is considerable, and the streamers of which it is composed appear to be nearly at right angles to the general line of the arch, their directions converging to a point a few degrees to the south of the zenith. As the arch moves forward towards the south, its lateral dimensions appear to contract, the intensity of its light increases, and the direction of the streamers, still tending to the same point in the heavens, approaches more nearly to parallelism with that of the arch. When it has passed the zenith, and arrived at the above-mentioned point, a little to the south of the zenith, the arch is seen as a narrow belt, three or four degrees only in breadth, and with well-defined edges. In its further progress southwards it again enlarges in breadth, and exhibits in a reverse order the same succession of changes as before. Hence the author concludes that the streamers have individually a position nearly vertical or parallel to the magnetic dip; and they form a thin fringe, stretching often to a great distance from east to west, at right angles to the magnetic meridian, and that the movement of the fringe from north to south takes place by the extinction of streamers at its northern side, and the formation of new ones contiguous to its southern side.

From a variety of observations which were detailed in this paper, the author infers, in opposition to the opinion of Mr. Dalton, that the region occupied by this meteor is above, but contiguous to, that of the clouds, or at least to that in which aqueous vapour is condensed, so as afterwards to appear in the form of clouds. The height of this region he estimates as in general about two thousand feet above the surface; and he is of opinion, that while such is the height of the lower ends of the vertical streamers, their upper ends may have an elevation of two or three thousand feet more.

Feb. 5.—A paper was read, intitled, "On a Differential Barometer," by the late William Hyde Wollaston, M.D. F.R.S. Communicated by Mr. Warburton.

The instrument described in this paper is capable of measuring, with considerable accuracy, extremely small differences of barometric pressure. It was originally contrived with the view of determining the force of ascent of heated air in chimneys of different kinds; but as its construction admits of any assignable degree of sensibility being given to it, it is susceptible of application to many other purposes of more extensive utility. A glass tube, of which the internal diameter is at least a quarter of an inch, being bent in the middle into the form of an inverted syphon, with the legs parallel to each other, is cemented at each of its open extremities into the bottom of a separate cistern, about two inches in diameter. One of these cisterns is closed on all sides, excepting where a small horizontal pipe opens from it laterally at its upper part; while the other cistern remains open. The lower portion of the glass tube is filled with water or

other fluid, to the height of two or three inches; while the remaining parts of the tube, together with the cistern, to the depth of about half an inch, are filled with oil; care being taken to bring the surfaces of water in both legs to the same level, by equalizing the pressure of the incumbent columns of oil. If the horizontal pipe be applied to the key-hole of a door, or any similar perforation in a partition between portions of the atmosphere in which the pressures are unequal, the fluid in the corresponding half of the instrument will be depressed, while it is raised in the opposite one, until the excess of weight in the column that is elevated will just balance the external force resulting from the inequality of atmospheric pressures upon the surface of oil in both cisterns. This, however, is equal only to the difference between the weight of the column of water pressing on one side, and that of an equal column of oil which occupies the same length of tube on the other side: this difference, depending upon the relative specific gravities of the two fluids, will, in the case of olive-oil and water, be about one-eleventh of the weight of the column of water elevated. But the sensibility of the instrument might be increased at pleasure, by mixing with the water a greater or less quantity of alcohol, by which the excess of its specific gravity over that of the oil may be reduced to one-twentieth, one-thirtieth, or any other assignable proportion. The instrument may be converted into an areometer, by closing both the cisterns, and by applying to the upper part of each a trumpet-mouthed aperture, opening laterally.

Feb. 12.—The President in the chair. A paper was read, intitled, "On the Reflection and Decomposition of Light, at the separating Surfaces of Media of the same and of different Refractive Powers," by D. Brewster, M.D. F.R.S., &c.

Feb. 19.—The President in the chair.—A paper was read, intitled, "Considerations of the objections raised against the geometrical representation of the square roots of negative quantities," by the Rev. J. Warren, M.A. of Jesus College, Cambridge. Communicated by Dr. Young.

LINNÆAN SOCIETY.

March 3.—A continuation was read of Mr. Don's paper on the *Compositæ* of South America.

March 17.—A paper was read on the Fig-trees of Jamaica, by James Mac Fadyen, Esq., Island Botanist: communicated by H. T. De la Beche, Esq., F.R.S., &c.—This paper describes six species indigenous to Jamaica. The genus is divided into two sections, according as the fruit is sessile or pedunculated. Under the 1st are enumerated *F. Simpsoni* and *F. cordifolia;* under the 2nd, *F. Jamaicensis, F. viridis, F. Americana,* and *F. lentiginosa.* The author states that the first four species are new, and that the characters of the rest had never before been properly investigated.

Some remarks by Mr. Bicheno on the geographical and geological distribution of Plants were also read: and the reading of Mr. Don's paper was continued.

FRIDAY-EVENING PROCEEDINGS AT THE ROYAL INSTITUTION OF GREAT BRITAIN.

Feb. 27.—Mr. Faraday gave an account of Brard's test of the action of weather on building materials. He prefaced his particular account of the test proposed, by a general view of the actions that go on in these climates upon the building materials ordinarily in use. The actions were considered as of two kinds, chemical and mechanical; instances of both were referred to and exhibited: the former were stated to produce more good than harm, but the latter to be decidedly and seriously injurious. The mechanical actions are of different kinds, but the action of water and frost are the most powerful: all of them are fully met by the proposed test, which consists in boiling prepared specimens of the materials to be tried in a solution of sulphate of soda, and then suspending them in the air and allowing evaporation to proceed until the salt crystallizes: by dipping the specimens into a cold saturated solution, and again causing crystallization to take place, an exact imitation of the effects of frost is produced. Mr. Faraday stated, that he had applied M. Brard's test soon after his first publication of it, and could bear testimony to its value. He said, that more lately it had been minutely applied and regulated in France, and was there also received with approbation. The mode of procedure was illustrated by specimens in progress.

Numerous specimens of Hindû and other sculpture were in the Library, illustrative of the effects of weathering.

March 6.—Mr. Brande gave an experimental development of Mr. Hennel's late experiments and discoveries relative to ætherification, and the nature of the substances produced by the action of alcohol and sulphuric acid. He more particularly illustrated Mr. Hennel's new view, that the sulphovinic acid is probably a necessary intermediate state in the production of æther. These researches have been published in two papers in the Philosophical Transactions, the first of which will also be found in Phil. Mag. vol. liv. p. 354.

March 13.—Mr. Brockedon on a new mode of sketching effects rapidly in chiaro-oscuro, and its application in lithography. This mode consists in applying the mezzotinto process either upon card-board or lithographic stone. After applying a uniform coat of black paint, or a mixture of lamp-black and pomatum, to card-board, the lights are taken out with a palette-knife, the finger, or any other convenient tool, and with more or less breadth, at pleasure. The same process applied on lithographic stone may be made to afford very fine texture and beautiful effects. It has been practised in Germany, France, and in this country, and numerous progressive specimens of the results were shown and referred-to.

March 20.—Mr. Ainger's development of the origin and early history of the steam-engine. Mr. Ainger's object was by a chronological arrangement of diagrams, faithfully representing the contrivances which at various periods have been proposed or executed to render steam an active and useful agent, and by the comparison of

these with each other as to principle, to trace out correctly the progress of the discovery of the steam-engine. He proceeded only about half-way through his subject, having only come down to the period of the Marquess of Worcester. His account so far does not at all accord with that of M. Arago, who professes to have done the same thing in the *Annuaire* for 1829. The subject will be continued.

ROYAL ACADEMY OF SCIENCES OF PARIS.

July 14th, 1828.—The Minister of the Interior sent to the Academy a description of a new clock, made by MM. Baillot and Le Roy. —M. Arago communicated a notice from M. Auguste de la Rive, respecting the phænomena of the voltaic pile.—The reading of a letter from M. Raspail was stopped by order of the President, on account of some improper expressions which it contained.—M. Pinel sent a further account relating to his inquiries on intellectual organization.—M. Rostan proposed himself as a candidate for the vacant place in the section of medicine.—M. Jaffart of Moissac wrote that he had made a discovery respecting the astronomical circle.—M. Gauvin gave an account of an improvement which might be made in all keyed instruments.—The Academy afterwards heard a verbal report by M. Latreille, respecting a work by M. Macquart, intitled, *Diptères du Nord de la France;*—the history of an unusual affection of the brain by M. Lugol;—a dissertation on the ligaments and muscles, by M. Gerdy.

July 21.—M. Raspail communicated an experiment, which appeared to him proper to explain the circulation remarked in the *chara*. —M. Gruithuisen returned thanks to the Academy for the medal which they had presented to him.—M. Conybeare also expressed his obligation for having been elected a corresponding member.—M. Arago read a letter from M. de la Rive, in which he related several new facts which are favourable to the purely chemical theory of the voltaic battery.—M. Poiteau offered himself as a candidate for the vacant place in the section of agriculture.—M. Vernier sent an extract from a memoir containing very simple therapeutic processes, applicable to all cases of poisoning.—M. Milne Edwards communicated some observations which he had made on the circulation of the *Nymphon gracilis*.

The remainder of the sitting was occupied by reading a very favourable report by M. Dumeril respecting the memoir of MM. Audouin and Edwards, On the respiration of the Crustacea;—by reading a report by M. Brochant on M. de Bonnard's observations made at the manganese mine of Romanèche near Maçon ;—and lastly, by reading a memoir by M. Beaujeu On the manufacture of beet sugar.

The section of Medicine afterwards presented the following list of candidates for the vacant place: MM. Serres, Edwards, Segalas, Desgenettes, Alibert, Double, et Bally. Several members expressed their surprise that the list did not contain the names of MM. Flourens and Broussais.

July 28.—The Minister of the Interior requested the Academy to name

name a candidate for the place vacant in the Jardin des Plantes, by the death of M. Bosc.—MM. Auguste, and Geoffroy Saint-Hilaire, Soulange Bodin, Girard and Dutrochet, offered themselves as candidates for the place vacant in the section of Agriculture.—M. Isidore Bourdon deposited a sealed packet relating to some physiological researches.—M. Brongniart read an extract of a letter from M. Julia Delanoue, stating that in the cave of Miremont, department of la Dordogne, fossil bones had been found in general similar to those of the caves of Germany, England, and France.—M. de Beaujeu communicated additional information respecting the manufacture of beet sugar.—M. Malbec sent a memoir On the periodical oscillations of the barometer.

Afterwards the following were read :—A memoir by M. Dutrochet On the grubbing up of the heath called *la gatine*, in the department of Vienne ;—a memoir by M. Sérullas On a new compound of chlorine and cyanogen ;—the Second Part of a dissertation by M. Gannel On the treatment of *phthisis pulmonalis* by chlorine ;—a work by M. Ville relating to the duration of the generations of man in the city of Paris, during the eighteenth century.

The Academy then proceeded to supply M. Chaussier's place. M. Serres having obtained 38 votes, was elected.

XLVII. *Intelligence and Miscellaneous Articles.*

EFFECTS OF LIGHT ON SOLUTION OF TARTAR-EMETIC AND ANTIMONIAL WINE.

DR. JOHN DAVY states, that when a solution of tartar-emetic is exposed for some weeks to the direct rays of the sun, in a close vessel, it is rendered turbid, and a precipitate forms, which has the properties of peroxide of antimony. In one instance, a drachm of tartar-emetic, dissolved in four ounces of distilled water, was exposed to sunshine at Corfu and Malta during twelve months ; the precipitate collected weighed one grain, and consisted of peroxide as well as protoxide of antimony. The decomposition from the action of the sun's rays takes place very slowly at first, till the solution has become turbid, and then the change is greatly accelerated. This probably is owing to the particles of oxide of antimony disengaged exerting an influence on the others, similar to what is witnessed in the experiment of the precipitation from an acid solution of one metal by another.

It might, perhaps, be expected that antimonial wine would be more liable to change from exposure to the sun's rays than a solution of tartar-emetic ; but the fact is the reverse. After a year's exposure, a portion of this wine, prepared according to the London Pharmacopœia, had undergone no change ; and two different samples of antimonial wine, one made with a sweet wine like Malaga, and another with a dry wine like sherry, which had been many years kept in the Mediterranean, exposed to dull light, were both as good as when first prepared. There was a very minute sediment of extractive matter in

in the first, and a more considerable one in the second, which appeared to be composed chiefly of tartrate of lime and vegetable colouring and extractive matter, without oxide of antimony.—*Jameson's Journal*, Dec. 1828.

NITRATE OF SILVER AS A TEST FOR VEGETABLE AND ANIMAL MATTER.

Dr. Davy states, that nitrate of silver dissolved in pure water is not altered by the sun's rays. If the minutest quantity of vegetable or animal matter is present, the solution is discoloured; and, with common distilled water, the discolouration is strong. To prove that the cause of the change of colour is the one assigned, it is sufficient to allow the coloured matter to subside, decant the colourless solution, and expose it again to sunshine. However powerful the sun's rays are, no further effect is produced; but add more common distilled water, and the phænomenon will instantly reappear. He believes nitrate of silver thus used is one of the best tests of the presence in water of very minute portions of vegetable matter; of course, any chloride of silver that may be formed in consequence of the presence of any muriates, should be allowed to subside in the dark, and the subsidence should be complete before the fluid is decanted and exposed to light.—*Ibid.*

SOLUBILITY AND MELTING POINT OF PHOSPHORUS.

Dr. Davy dissents from the common opinion, that phosphorus is insoluble in water: a piece of phosphorus immersed for twenty-four hours in distilled water imparted to it, even after it was filtered, a smell of phosphorus, and it was even perceptibly luminous in the dark. With respect to the melting point of phosphorus, Dr. Davy observes, that according to Pelletier it melts at 99°; according to Dr. Thomson, at 108°: the phosphorus, however, which Dr. D. tried melted at 112°; at 110° he has found it brittle, and very easily reducible to powder. Gradually and very slowly cooled in a solution of potash, phosphorus may remain liquid at 72°, but when touched with the thermometer it became instantly solid.—*Ibid.*

[Although I have no doubt that phosphorus was actually dissolved in the above-mentioned experiment, yet, as I have endeavoured to prove in the Annals of Philosophy, it exists, in the solution I believe, in the state of phosphuretted hydrogen.—R. P.]

ACTION OF SULPHURETTED HYDROGEN GAS ON SOLUTIONS OF MERCURY. BY M. ROSE.

The precipitate obtained by the action of sulphuretted hydrogen on a solution of chloride of mercury remains long suspended in the liquid, to which it imparts a milky appearance; it is very difficult to filter, it dries readily, and then much resembles white precipitate of mercury. At a high temperature it is decomposed; if it be slowly heated in a glass tube closed at one end, chloride of mercury first sublimes, and afterwards sulphuret of mercury. This compound perfectly

perfectly resists the action even of concentrated acids; it is only by heating it in nitric acid, and then adding muriatic, that sufficient action is exerted to convert all the sulphur into sulphuric acid.

When this compound is treated with chlorine gas and heat, chloride of sulphur is at first disengaged, and afterwards sublimate. The alkalies and their carbonates blacken it, especially with the assistance of heat: as the results of this decomposition, the liquid contains chloride of potassium and sodium, and the black precipitate consists of a mixture of oxide and sulphuret of mercury; there is no chloride of mercury, as has been supposed. The different analyses which I have made having given results almost identical with the data of calculation, this compound is formed of 1 atom of chloride of mercury = 36·8, and 2 atoms of sulphuret of mercury = 63·20. Thus, by the action of sulphuretted hydrogen on a solution of sublimate, there is first obtained sulphuret of mercury, which, combining with the undecomposed chloride, forms a substance insoluble in water. If the quantity of sulphuretted hydrogen be too great, all the chloride is decomposed, and all the precipitate is sulphuret of mercury.

Analogous phænomena are observed when a solution of bromide of mercury is similarly treated. The solution becomes milky; the dried precipitate resembles the former, except in being slightly yellow; it acts in the same way with the concentrated acids; the alkalies blacken it, but not so strongly; it is decomposed by heat into bromide of mercury and sulphuret of mercury. The composition of this body is analogous to the preceding; that is to say, it is formed of an atom of bromide of mercury and two atoms of sulphuret of the same metal.

The iodide and fluoride of mercury treated with sulphuretted hydrogen, furnish precipitates, the combination of which is absolutely analogous. The precipitate of the latter is white and heavy, and is distinguished from the others by being decomposed by boiling water, into fluoride and black sulphuret of mercury; when heated in a glass tube, one end of which is closed, it is resolved into fluosilicic gas and mercury, whilst at the point of the greatest heat sulphuret of mercury sublimes.

This precipitate is decomposed by concentrated sulphuric acid when heated (which does not occur with the others). Treated simply with the alkalies, it becomes red; on the contrary, it becomes black when boiled with these bodies.

The mercurial oxisalts act with sulphuretted hydrogen in the same manner as the combination of this metal, with bromine, chlorine, and fluorine. The precipitates which are obtained at first are white, and more readily deposited; they are also more easily filtered; they are composed of sulphuret of mercury and a small quantity of the salt employed. Thus the precipitate obtained with nitrate of mercury is white; when heated in a glass tube, it yields a small quantity of sulphuret of mercury, which sublimes, much metallic mercury, nitrous vapours, and sulphuric acid: it acts with acids in the same manner as the precipitate furnished by the chloride: the alkalies give it first a yel-

a yellow colour, and finish by rendering it black; when heated to ebullition, it blackens immediately. It is formed of 2 atoms of sulphuret of mercury, and 1 atom of anhydrous neutral nitrate of mercury. The solution of cyanide of mercury is an exception to the general rule: in this, the smallest quantity of sulphuretted hydrogen occasions the formation of black sulphuret of mercury.—*Hensman's Repertoire*, Nov. 1828.

PROFESSOR BESSEL'S PENDULUM EXPERIMENTS.

Professor Bessel has lately published the First Part of his Pendulum Experiments, which contains the investigation of the length of the pendulum at Kœnigsberg. We shall probably lay before our readers in a future Number of this Journal, either a translation or an abstract of this most interesting and important publication. In the mean time we communicate the final results which Prof. B. has obtained:

	lines.	
Length of the seconds pendulum in the Observatory of Kœnigsberg..	440·8147	Paris measure by the toise of Peru.
The same reduced to the level of the Baltic	440·8179	

SCIENTIFIC BOOKS.

Just published.

Principles of Natural Philosophy; or a New Theory of Physics, founded on Gravitation, and applied in explaining the general properties of Matter, the Phænomena of Chemistry, Electricity, Galvanism, Magnetism, and Electro-Magnetism. By Thomas Exley, A.M. Associate of the Bristol Philosophical and Literary Society.

Preparing for Publication.

The British Merchant's Assistant.—Part I. Tables of Simple Interest, at 3, $3\frac{1}{2}$, 4, $4\frac{1}{2}$, and 5 per cent, calculated from 1 to 365 days, from 1 to 12 months, and from 1 to 14 years; on amounts from £1 to £20,000.

Part II. Tables for computing the premium and discount on Exchequer Bills and India Bonds; also the Interest on Exchequer Bills, at $1\frac{1}{2}d.$ $1\frac{3}{4}d.$ $2d.$ $2\frac{1}{4}d.$ $2\frac{1}{2}d.$ $2\frac{3}{4}d.$ $3d.$ $3\frac{1}{4}d.$ and $3\frac{1}{2}d.$ per cent, *per diem*, from 1 to 365 days; on amounts from £100 to £20,000.

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The whole constructed on a more extended scale than any similar Tables hitherto published, and arranged in a novel and perspicuous manner. By G. Green. In one large volume; price to Subscribers, £1 11*s.* 6*d.*

Results

Results of a Meteorological Journal for the Year 1828, *kept at the Observatory of the Royal Academy, Gosport, Hants.*

By William Burney, *LL.D.*

Latitude 50° 47′ 20″ North: Longitude 1° 7′ West of Greenwich—In time 4′ 28″.

1828. Months.	Barometer.										Self-registering Thermometer.								Mean Temp. of Spring Water.	De Luc's Hygrometer.						
	Max.	Min.	Media.	Range.	No. of Changes.	Spaces described.	Greatest Variation in 24 hours.	Media at 8 A.M.	Media at 2 P.M.	Media at 8 P.M.	Max.	Min.	Media.	Mean Range.	Gt. Var. in 24 hours.	Media at 2 P.M.	Media at 8 A.M.	Media at 8 P.M.		Max.	Min.	Mean Range of the Index.	Media at 2 P.M.	Media at 8 A.M.	Media at 8 P.M.	Media at 8,2,&8 o'cl.
	In.	In.	In.	In.		In.	In.	In.	In.	In.	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Jan.	30·40	29·17	29·895	1·23	22	6·74	0·53	29·892	29·882	29·904	56	29	44·95	27	17	47·80	42·90	44·58	52·57	100	63	37	80·8	87·4	89·8	86·0
Feb.	30·44	28·90	29·763	1·54	17	6·25	0·57	29·752	29·755	29·778	61	28	45·74	33	17	49·65	43·34	45·03	51·56	100	59	41	71·6	82·1	81·8	78·5
Mar.	30·30	29·02	29·879	1·28	17	5·64	0·58	29·879	29·880	29·882	63	30	47·92	33	23	53·84	45·16	46·32	50·86	100	44	56	58·4	73·0	71·4	67·6
April	30·28	29·10	29·736	1·18	18	5·55	0·38	29·737	29·737	29·729	69	35	51·33	34	20	55·80	48·63	49·93	50·89	88	42	46	60·0	65·0	74·4	66·5
May	30·32	29·36	29·826	0·96	18	4·12	0·44	29·830	29·826	29·824	76	42	58·76	34	24	64·93	56·90	56·42	51·29	84	40	44	33·0	57·0	64·9	58·3
June	30·33	29·35	29·982	0·98	18	4·61	0·55	29·981	29·989	29·982	81	48	63·63	33	24	70·73	63·27	61·87	52·44	86	40	46	51·2	57·7	63·7	57·5
July	30·03	29·24	29·711	0·79	30	4·22	0·43	29·703	29·720	29·713	82	47	65·55	35	25	72·00	65·19	62·90	54·15	92	41	51	53·5	61·1	67·2	60·6
Aug.	30·29	29·36	29·860	0·93	22	4·30	0·43	29·856	29·857	29·863	76	47	63·18	29	25	68·39	62·32	60·68	55·20	94	45	49	59·5	66·4	71·5	65·8
Sept.	30·52	29·43	29·926	1·09	20	4·36	0·42	29·933	29·924	29·920	74	48	61·28	26	21	66·80	59·73	59·60	55·85	94	45	49	60·9	70·2	71·4	67·5
Oct.	30·42	29·35	30·050	1·07	23	4·80	0·39	30·045	30·049	30·056	65	35	53·69	30	20	58·55	51·39	52·38	56·06	100	38	62	60·9	72·5	75·6	69·6
Nov.	30·26	29·23	29·856	1·03	18	4·22	0·43	29·856	29·847	29·856	60	29	49·52	31	21	53·20	47·17	48·96	55·38	94	57	37	68·4	77·2	78·1	74·5
Dec.	30·32	29·20	29·930	1·12	20	7·26	0·63	29·928	29·927	29·932	57	34	48·40	23	16	51·35	47·48	48·39	54·34	100	57	43	74·2	80·0	79·9	78·0
Aver.	30·52	28·90	29·868	13·20	243	62·07	0·63	29·866	29·866	29·870	82	28	54·49	30·66	25	59·42	52·79	53·09	53·38	100	38	46·7	62·7	70·8	74·1	69·2

TABLE

TABLE (continued).

1828.	Scale of the Winds.									Modifications of Clouds.							Weather.						Atmospheric Phænomena.									Evaporation in Inches, &c.	Rain in Inches, &c.
	North.	North-East.	East.	South-East.	South.	South-West.	West.	North-West.	Total Number of Days.	Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostratus.	Nimbus.	A clear Sky.	Fair, with Clouds.	An overcast Sky.	Foggy.	Rain, &c.	Total Number of Days.	Anthelion.	Parhelia.	Paraselenæ.	Solar Halos.	Lunar Halos.	Rainbows.	Meteors.	Lightning.	Thunder.		
January ..	½	3½	3½	6	4	7	4	2½	31	16	8	30	1	8	9	19	2	9	11½	1	7½	31	...	2	...	...	1	...	2	...	...	0·60	6·710
February	5	2	1	7	2	6	4	2	29	14	8	29	1	10	17	20	2	9½	12½	½	4½	29	...	...	...	2	1	1	2	...	...	0·75	1·515
March ...	3½	2½	1	3	½	6	5½	9	31	12	6	24	1	19	25	15	4½	15	7½	1	3	31	...	...	...	1	1	...	1	1	1	1·90	1·755
April	1	5	...	5½	1½	10	3½	3½	30	20	12	26	...	15	25	22	2	11½	9½	...	7	30	...	...	1	4	2	1	1	...	...	2·20	2·725
May	1	5	4	7	2½	5½	3	3	31	23	20	27	...	27	24	21	5	12½	8	...	5½	31	...	...	...	2	1	...	3	2	2	3·95	2·290
June ...	2	3	2½	4	3	8	2½	5	30	25	16	29	...	29	23	14	5	17	4	...	4	30	1	1	...	4	...	2	...	4	4	4·65	1·980
July	2	...	½	4	2½	12	5	5	31	26	17	30	...	27	27	26	2½	15	8½	...	5	31	...	...	...	9	1	1	1	3	3	3·70	3·405
August ..	1	4½	2½	3	1	12	3	4	31	23	15	30	...	24	26	21	4½	12	9	...	5½	31	...	3	...	2	...	...	44	1	3	3·05	2·585
September	1	7	4	5	2	7½	2½	1	30	24	18	30	...	19	23	15	3½	15	7	½	4	30	...	...	6	3	4	...	40	4	3	2·80	2·280
October ..	1	5	4½	2	3	5	4	6½	31	20	11	30	6	21	15	10	5	13½	8½	1	3	31	...	...	...	1	...	...	18	2	2	1·60	1·690
November	2	2½	4	5	3	6½	5½	1½	30	20	13	30	2	12	13	12	1½	13	11	1	3½	30	...	2	...	2	5	1	17	...	...	1·05	1·875
December	1	½	2	4½	6½	8½	7	1	31	13	5	30	1	13	19	20	3	8½	12	½	7	31	...	5	...	1	2	3	12	2	2	0·95	3·825
Results for 1828.	21	40½	29½	56	31½	94	49½	44	366	236	149	345	12	224	246	215	40½	151½	109	5½	59½	366	1	13	7	31	18	9	141	19	20	27·20	32·635

ANNUAL RESULTS FOR 1828.

Barometer.	Inches.
Greatest pressure of the atmosphere, Sept. 16th. Wind N.E.	30·520
Least ditto ditto Feb. 21st. Wind S.E.	28·900
Range of the quicksilver	1·620
Annual mean pressure of the atmosphere	29·868
Mean pressure for 201 days with the moon in North decl.	29·862
——— for 183 days with the moon in South decl.	29·883
Annual mean pressure at 8 o'clock A.M.	29·866
——— at 2 o'clock P.M.	29·866
——— at 8 o'clock P.M.	29·870
Greatest range of the quicksilver in February	1·540
Least range of ditto in July	0·790
Greatest annual variation in 24 hours in December	0·630
Least of the greatest variations in 24 hours in April	0·380
Aggregate of the spaces described by the rising and falling of the quicksilver	62·07
Number of changes	243·

Self-registering Day and Night Thermometer.	Degrees.
Greatest thermometrical heat, July 3rd. Wind S.W.	82
——— cold, February 12th. Wind N.	28
Range of the thermometer between the extremes	54
Annual mean temperature of the external air	54·49
——— of do. at 8 A.M.	52·79
——— of do. at 8 P.M.	53·09
——— of do. at 2 P.M.	59·42
Greatest range in July	35·00
Least of the greatest monthly ranges in December	23·00
Annual mean range	30·66
Greatest monthly variation in 24 hours in July and August	25·00
Least of the greatest variations in 24 hours in December	16·00
Annual mean temperature of spring water at 8 o'clock A.M.	53·38

De Luc's *Whalebone Hygrometer.*

	Degrees.
Greatest humidity of the atmosphere, several times in different months	100
Greatest dryness of ditto, October 29th	38
Range of the index between the extremes	62
Annual mean state of the hygrometer at 8 o'clock A.M.	70·8
——— at 8 o'clock P.M.	74·1
——— at 2 o'clock P.M.	62·7
——— at 8, 2, and 8 o'clock	69·2
Greatest mean monthly humidity of the atmosphere in Jan.	86·0
——— dryness of ditto in June	57·5

Position of the Winds.	Days.
From North to North-east	21
—— North-east to East	40½
—— East to South-east	29½
—— South-east to South	56
—— South to South-west	31½
—— South-west to West	94
—— West to North-west	49½
North-west to North	44
	366

Clouds, agreeably to the Nomenclature, or the Number of Days on which each Modification has appeared.

	Days.		Days.
Cirrus	236	Cumulus	224
Cirrocumulus	149	Cumulostratus	246
Cirrostratus	345	Nimbus	215
Stratus	12		

General State of the Weather.	Days.
A transparent atmosphere without clouds	40½
Fair, with various modifications of clouds	151½
An overcast sky without rain	109
Foggy	5½
Rain, hail, and snow	59½
	366

Atmospheric Phænomena.	No.
Anthelion, or mock-sun, diametrically opposite to the sun	1
Parhelia, or mock-suns on the sides of the true sun	13
Paraselenæ, or mock-moons	7
Solar halos	31
Lunar halos	18
Rainbows	9
Meteors of various sizes	141
Auroræ Boreales	3
Lightning, days on which it happened	19
Thunder, ditto ditto	20

Evaporation.	Inches.
Greatest monthly quantity in June	4·65
Least monthly quantity in January	0·60
Total amount for the year	27·20

Rain.	
Greatest monthly depth in January	6·710
Least monthly depth in February	1·515
Total amount for the year, near the ground	32·635

The instruments are the same, and were placed in the same situation as described in the Phil. Mag. and Annals, N. S. vol. i. p. 165, in the Results of the Meteorological Journal for Hampshire, for 1826.

BAROME-

Barometrical Pressure.—The mean height of the mercurial column of the barometer this year, is 4-125ths of an inch lower than it was in the preceding, and 19-1000dths of an inch lower than the mean of the last thirteen years. Both the aggregate of the spaces described by the alternate rising and falling of the quicksilver, and the number of changes, fall considerably short of their yearly mean amount, and indeed of any year since 1815; an indication that the elasticity of the atmosphere has been less disturbed by the prevailing winds, &c. notwithstanding that the gales are as many in number as have occurred in any year since the boisterous year 1821. In July and the first fortnight of August, the mean pressure was lower than in any other part of the year.

Temperature.—The mean temperature of the external air this year is unprecedentedly high, being 2·38 degrees higher than the mean of the last thirteen years, and 0·48, or nearly half a degree higher than the mean of the warm year 1822. By comparing the monthly mean temperatures, this remarkable circumstance appears to have arisen from the high mean temperature of January, February, November and December, as it will be recollected that the winter and autumn were uncommonly mild; but in both these seasons the atmosphere was very humid.

The difference between the annual mean temperature of the air as taken at 8 A.M. and 8 P.M., is only 3-10ths of a degree. The mean temperature of spring water this year is also higher than it has been since 1822; as there was no penetrating frost to lessen the temperature of the ground.

Wind.—It will be seen by the scale of the winds, that those from the S.E. and S.W. prevailed much longer than from any other given point of the compass: their duration this year is without a parallel, particularly from the former point, which prevailed mostly in the winter and spring, and from the S.W. in the summer months. The S.E. wind is here generally found to be a dry land wind, and its unusual prevalence may in some measure account for the high annual mean temperature of the atmosphere. The S.W. wind from the Western Ocean is moist, and, on uniting with the land air, very often brings on haze, or rain, shortens the mercurial column, and lessens evaporation considerably.

The number of strong gales, or the days on which they have prevailed this year, is as in the following scale:

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Gales.
5	17	4	12	6	35	14	7	100

The number from the S.W. is remarkable, as usual.

Rain.—Both the rain and evaporation are less than their annual average amounts for many years past. The only three very wet months were January, July, and December. In January nearly seven inches of rain fell here, although there were fifteen days without any that was measurable; and it is remarkable that nearly two inches

inches of this unusual amount fell in about ten hours on the first day of the year.

The rainy weather in July and the first fortnight of August, excited much anxiety among the agriculturists in general for the fate of the corn harvest; and although there were many intervals of strong sunshine, yet much of the wheat was spoiled by the continual rain, and the consequent floods in the vales and low lands of several counties.

LIST OF NEW PATENTS.

To J. H. Caney, of Aylesbury-street, Clerkenwell, for improvements in umbrellas and parasols.—Dated the 23rd of January, 1829.—2 months allowed to enroll specification.

To J. Fraser, of Limehouse, for an improved arrangement of flues to communicate with the various parts of culinary apparatus, such as steam-boilers, ovens, hot plates, or closets, and stewing-stoves.—27th of January.—2 months.

To J. Braithwaite, and J. Ericsson, of the New Road, Fitzroy-square, for their method of converting liquids into steam.—31st of January.—6 months.

To Lieut. R. Parker, R.N. of Hackney, for an improved drag or apparatus applicable to stage-coaches and other wheel-carriages, and whereby the motion thereof may be retarded or stopped when required.—31st of January.—2 months.

To J. Rayner, of King's-square, Old-street, for his improvements in apparatus for conducting heat and applying it in washing, scouring, dressing, dyeing, and finishing woollen cloths, and in calendering, straining, &c.—5th of February.—6 months.

To J. Pumphrey, of Tally Hill, Worcestershire, for improvements in steam-engines and machinery for propelling steam-boats.—3rd of February.—2 months.

METEOROLOGICAL OBSERVATIONS FOR FEBRUARY 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·52 Feb. 3. Wind S.—Min. 29·02 Feb. 21. Wind N.
Range of the index 1·50.
Mean barometrical pressure for the month ..... 29·993
Spaces described by the rising and falling of the mercury..... 4·700
Greatest variation in 24 hours 0·540.—Number of changes 17.
Therm. Max. 56° Feb. 20 & 27. Wind S.W. & N.E.—Min. 27° Feb. 1. Wind E.
Range 29°.—Mean temp. of exter. air 44°·48. For 30 days with ☉ in ♒ 40·30
Max. var. in 24 hours 19°·00—Mean temp. of spring water at 8 A.M. 50°·32

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the air in the evenings of the 15th and 26th... 89°
Greatest dryness of the air in the afternoons of the 1st and 2nd ... 54
Range of the index..... 35
Mean at 2 P.M. 68°·3—Mean at 8 A.M. 76°·6—Mean at 8 P.M. 75·3
—— of three observations each day at 8, 2, and 8 o'clock..... 73·4
Evaporation for the month 0·70 inches.
Rain near ground 0·90 inches.
Prevailing wind, East.

Summary

Summary of the Weather.

A clear sky, 2; fine, with various modifications of clouds, 6; an overcast sky without rain, 13; foggy, 1; rain, 6.—Total 28 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
7	3	26	1	4	11	17

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
4	3½	5	4	2	3½	2	4	28

General Observations.—This month has been generally calm and cloudy, with frequent light showers, yet mild for the season. Although it has rained more or less on fourteen days, the amount that has fallen at the ground is not an inch in depth.

In consequence of the prevailing vapours and low haze, the amount of evaporation is unprecedentedly low; indeed, it is remarkable that the sun and moon have only appeared a few times during the last two months. The first three days of the month the weather was fine, and the nights frosty, since which the thermometer has only receded once to the freezing point, and for several nights it has not gone lower than 46 degrees.

The mean temperature of the external air this month, is 2½ degrees higher than the mean of February for the last thirteen years; yet from the absence of the sun's rays the surface of the ground has received but little heat, and the spring has therefore been retarded,—a circumstance very generally favourable to the blooming season.

In the evening of the 27th, several strong flashes of lightning emanated from the clouds to the southward, which appeared to have been effected by two nearly opposite winds that had prevailed several hours.

The atmospheric and meteoric phænomena that have come within our observations this month, are one lunar halo in the evening of the 19th, two meteors in the evening of the 27th, and two gales of wind, one from the South, the other from the South-west.

REMARKS.

London.—Feb. 1—3. Clear and cold, with slight fog at night. 4. Rainy. 5. Cloudy. 6. Drizzly. 7. Cloudy. 8. Drizzly. 9. Cloudy. 10. Fine: drizzly at night. 11, 12. Cloudy. 13. Drizzly in the morning: fine. 14. Very fine. 15. Cloudy, with slight showers. 16, 17. Fine. 18. Clear and cold. 19. Very fine. 20, 21. Showery. 22. Cloudy, with slight showers. 23. Clear and cold. 24. Hazy. 25. Drizzly. 26. Rainy. 27. Drizzly. 28. Fine.

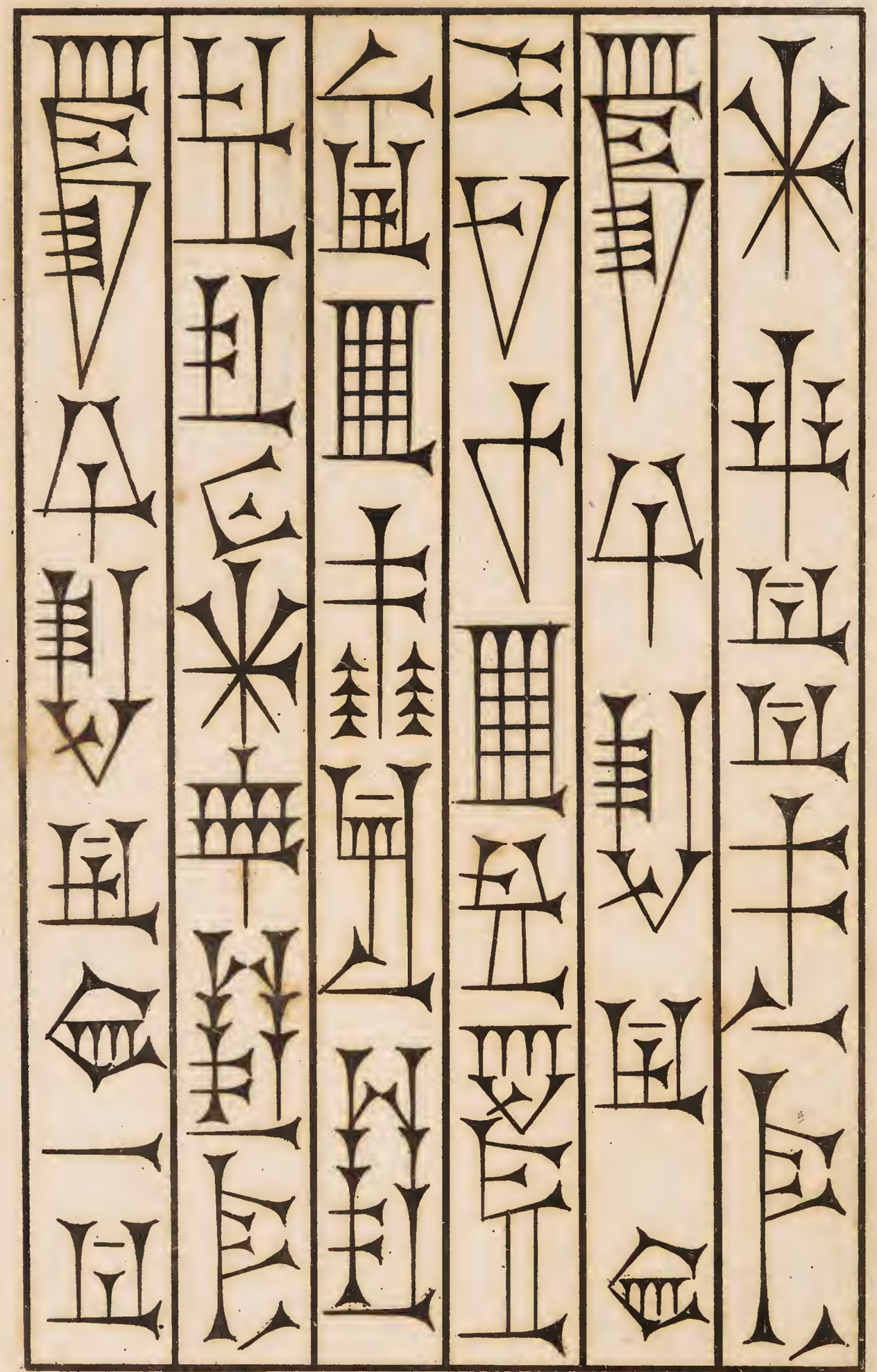
Penzance.—Feb. 1, 2. Fair. 3. Fair: clear. 4. Fair. 5. Misty: fair. 6—11. Fair. 12. Misty: rain. 13. Fair. 14. Misty: rain. 15, 16. Fair. 17. Misty: fair. 18. Fair. 19. Fair: rain: fair. 20. Clear: rain. 21. Rain. 22. Misty: clear. 23. Clear: cloudy. 24. Fair: showers. 25. Showers. 26. Rain: fair. 27. Fair: clear. 28. Fair.

Boston.—Feb. 1—3. Fine. 4. Cloudy: rain A.M. 5—10. Cloudy. 11. Cloudy: rain early A.M. 12. Cloudy: rain P.M. 13, 14. Cloudy. 15, 16. Fine. 17, 18. Cloudy. 19, 20. Fine. 21. Cloudy: rain A.M. and P.M. 22—25. Cloudy. 26. Cloudy: rain at night. 27. Rain. 28. Fine.

Meteoro-

Meteorological Observations made by Mr. BOOTH at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1829.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston 8½ A.M.	London.		Penzance.		Gosport.		Bost. 8½ A.M.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.										
Feb. 1	30·568	30·467	30·36	30·35	30·44	30·34	30·11	38	15	44	34	43	27	29·5	NE.	SE.	NE.	calm	...	...	...	...	...
2	30·615	30·606	30·50	30·38	30·50	30·48	30·25	38	17	41	36	37	30	24	SE.	SE.	SE.	calm	...	...	...	...	...
3	30·665	30·608	30·50	30·50	30·52	30·52	30·26	39	24	45	39	40	33	23	SW.	S.	S.	NW.	...	...	...	...	...
● 4	30·480	30·263	30·50	30·45	30·39	30·22	30·10	40	38	49	37	44	43	35	SW.	NW.	W.	NW.	0·15	·18	...	0·010	...
5	30·275	30·203	30·35	30·30	30·26	30·14	29·83	45	34	50	39	49	40	40·5	NW.	NW.	N.	N.	...	...	...	...	0.05
6	30·378	30·275	30·35	30·35	30·28	30·23	30·00	44	39	48	45	49	41	37	W.	NW.	W.	W.	...	·02	...	·010	...
7	30·198	30·156	30·34	30·30	30·16	30·10	29·80	47	38	48	42	51	41	40·5	NW.	NW.	NW.	NW.	·05	·05	...	·020	...
8	30·374	30·247	30·32	30·30	30·35	30·26	30·00	42	31	50	45	46	23	37	S.	N.	NE.	calm	...	·01	...	...	...
9	30·358	30·328	30·38	30·35	30·29	30·26	29·98	45	35	48	43	47	41	36·5	SW.	N.	N.	calm	...	...	...	...	...
☽ 10	30·475	30·465	30·38	30·36	30·35	30·33	30·05	45	38	48	44	47	41	36·5	W.	N.	SE.	calm	·05	·04	...	·010	...
11	30·342	30·271	30·45	30·40	30·30	30·26	29·95	46	40	49	44	52	46	42	W.	NW.	NW.	calm	...	...	...	·050	·08
12	30·208	30·192	30·35	30·25	30·21	30·18	29·85	48	42	50	45	52	46	44	NW.	NW.	SE.	calm	...	...	...	·050	...
13	30·194	30·186	30·25	30·25	30·13	30·12	29·73	48	40	50	47	51	44	44·5	NW.	N.	N.	calm	·10	·03	0·165	...	·04
14	30·194	30·176	30·20	30·15	30·12	30·10	29·73	50	41	51	45	53	44	41·5	W.	SW.	W.	calm	...	...	·085	·060	...
15	30·120	30·087	30·10	30·08	30·08	30·06	29·65	51	42	51	47	53	45	44	W.	SW.	SW.	calm	...	·01	·240	·030	...
16	30·052	29·875	30·05	29·95	30·00	29·83	29·54	52	40	52	47	54	42	45	NW.	S.	SW.	calm	·05	...	...	...	...
17	29·906	29·886	29·75	29·73	29·79	29·74	29·42	50	35	52	47	55	40	41	SE.	SE.	E.	E.	...	...	...	...	...
○ 18	29·913	29·816	29·73	29·70	29·79	29·67	29·57	40	34	50	46	45	41	35·5	E.	SE.	E.	calm	...	...	...	...	...
19	29·780	29·608	29·55	29·53	29·56	29·52	29·35	52	34	53	48	50	43	36	SE.	SW.	SE.	NE.	·05	...	·280	·015	...
20	29·683	29·662	29·63	29·25	29·58	29·51	29.20	52	40	53	48	56	45	40·5	SW.	SW.	S.	SW.	...	·21	·345	·225	...
21	29·248	29·102	29·10	29·05	29·10	29·02	28·93	52	38	48	46	55	43	42	SE.	W.	SE.	NE.	...	·05	·640	·010	...
22	29·390	29·221	29·35	29·25	29·26	29·15	28·82	46	35	50	44	53	38	43	N.	NW.	NW.	NE.	·05	...	·320	...	·36
23	29·569	29·534	29·45	29·40	29·43	29·40	29·22	42	31	50	40	45	37	36·5	E.	SE.	NE.	calm	...	...	·010	·010	...
24	29·590	29·479	29·45	29·35	29·46	29·34	29·14	40	33	51	43	46	39	33·5	E.	W.	NE.	calm	...	...	·100	...	...
25	30·138	29·974	29·85	29·78	29·96	29·83	29·60	42	35	53	45	50	43	37	E.	W.	SE.	calm	·05	·03	·075	·050	...
☾ 26	30·140	30·015	29·95	29·90	29·94	29·87	29·83	42	38	55	50	49	46	36	E.	SW.	E.	E.	...	·38	·750	·350	...
27	30·362	30·126	30·25	30·20	30·22	30·08	29·80	44	31	54	50	56	37	35	NE.	NW.	N.	calm	...	·06	...	...	·59
28	30·419	30·344	30·20	30·10	30·38	30·20	30·03	43	24	48	44	43	31	34	E.	SE.	E.	calm	·15	...	...	...	...
Aver.:	30·665	29·102	30·50	29·05	30·52	29·02	29·70	52	15	55	34	56	27	37·5					0·70	1·07	3·005	0·900	1·12

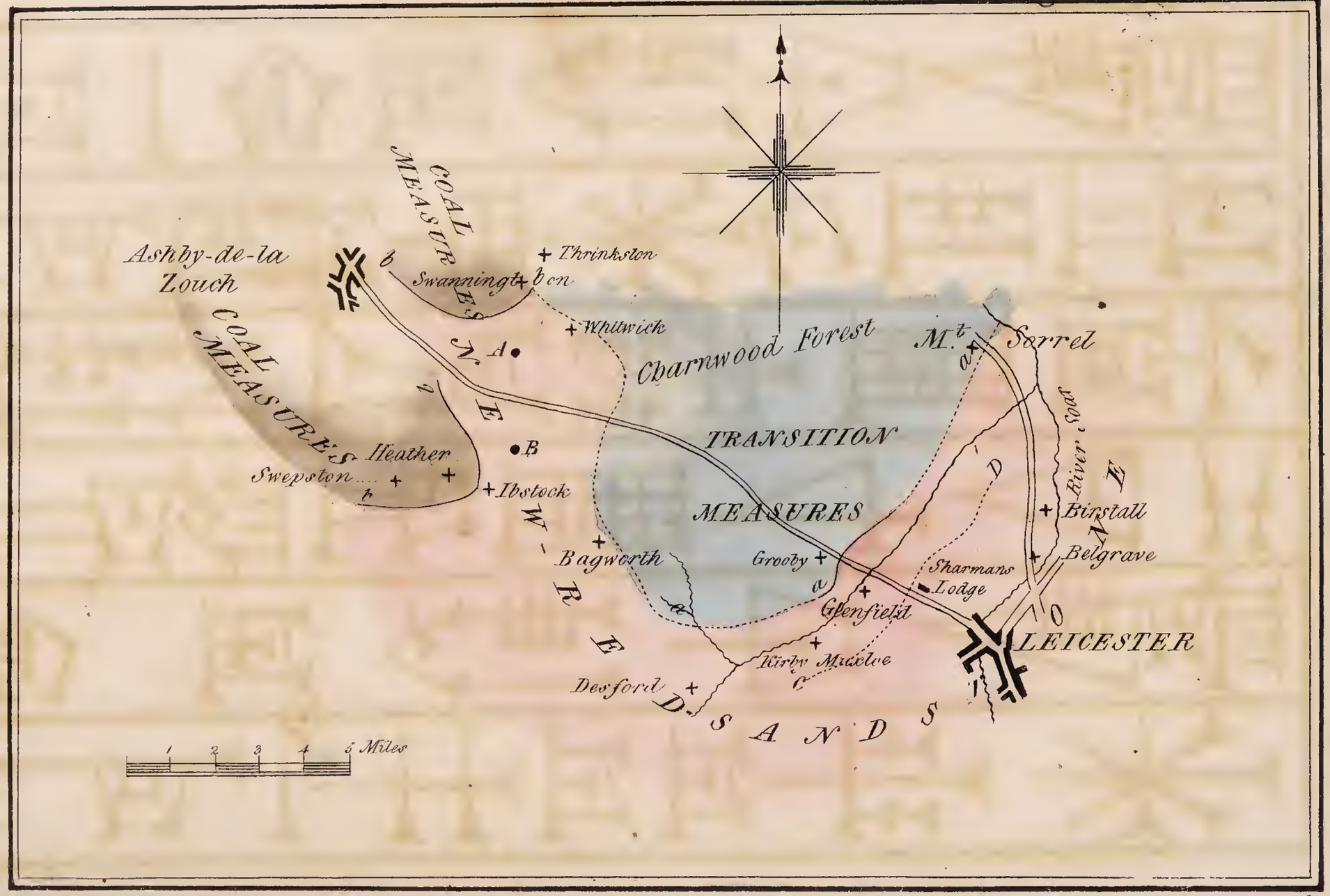


𐎧𐎠𐎧𐎢𐎼𐎠𐎡𐎧𐎢𐎹𐎠𐎧𐎢𐎼	*Xerxes.*
𐎧𐎠𐎧𐎢𐎼𐎠𐎼𐎠𐎡𐎠𐎢𐎠𐎠𐎢𐎹	*rex.*
𐎠𐎼𐎠𐎡𐎹𐎠𐎢𐎺 𐎧𐎢𐎧𐎠𐎧𐎢	*Darius.*

Fig. 2.



Phil. Mag. & Annals. N.S. Vol. 4. Pl. 5.



Drawn by F. FORSTER.

W. DAY, Litho. 17, Gate Str.

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ROYAL MEDICAL SOCIETY OF LONDON

XLVIII. *On the ancient Inscriptions of Persepolis. By the Rev.* John Kenrick, *M.A.**

[With a Plate.]

THE brilliant success which has attended the researches of Champollion and Young into the writing of the ancient Egyptians, has drawn the attention of all who take an interest in historical investigations, and will probably change in a few years our whole system of Egyptian antiquities. It is the object of the present paper to give some account of the attempts which have been made to decipher another species of ancient writing—that which is found upon the remains of Persepolis, and upon other monuments within the limits of the empire possessed by the successors of Cyrus. In offering this account to the Society, I profess nothing more, than to trace the discoveries of some continental writers, whose works I have reason to believe are almost wholly unknown in this country.

The character in question is formed from a very simple element (𐎡), a stroke which, when elaborately made, resembles the head of an arrow; when less carefully cut or impressed, a wedge or a nail; and hence the inscriptions have been called *arrowheaded*, *nailheaded* or *cuneiform*. Those of Persepolis, being cut in marble, are arrowheaded, those of the Babylonian bricks are chiefly nailheaded †; but the difference appears not to be essential, as many of the latter are formed in the same way as the Persepolitan characters. It has been conjectured that the use of the arrow for purposes of divination (Ezekiel xxi. 21.) may have given rise to its employment as the element of the Assyrian and Persian characters. Two of these strokes are joined together by the broad end, forming a cha-

* Read before the Yorkshire Philosophical Society; and communicated by the Author. † See Plate III.

racter resembling a pair of compasses partly opened (⟨), but with this exception, the letters are formed not by the junction but the juxtaposition or superposition of the arrowheaded strokes, so that many of them occupy a large space.

The travels of Chardin, Le Bruyn, and Kæmpfer, towards the close of the seventeenth century, had made known the magnificence of the ruins of Tchilminâr, and the inscriptions which remain on various parts of this palace of the ancient kings of Persia. But the travellers of that age seldom paid sufficient attention to copying inscriptions, especially in characters which they did not understand. It was not till after Niebuhr, on his return from Arabia and India, visited Persepolis, and published his exact copies of the inscriptions there, that curiosity was effectually excited, to discover the alphabet in which they were written, and the language the sounds of which they expressed. No external aid was to be expected; the Greek and Latin writers never mention them; the modern Persians know Persepolis only as the palace of their fabulous monarch Djemsheed, and the repository of his countless treasures. Sir William Ouseley, in his Oriental Collections (ii. 57.), has given, from the MS. of a Mahometan author, what professes to be a Persepolitan alphabet; but it is the mere work of fancy, like several other alphabets which the same MS. contains.

The first author, as far as I am aware, who published anything on this subject, was Professor O. G. Tychsen of Rostock, in his *Lucubratio de Cuneatis Inscriptionibus Persepolitanis*, 1798. He was followed in 1802 by Professor Münter of Copenhagen, in a German work, entitled "An Attempt to decipher the Cuneiform Inscriptions of Persepolis." Both these authors proceeded with the caution which is necessary in so difficult an undertaking; and if they made little progress, that little was in a right direction. They ascertained that the inscriptions were alphabetical, that the words are divided by a character placed obliquely (⟍), and that they are to be read from left to right, like the Indian and European alphabets; not from right to left, like those of the Aramæan nations: they also pointed out the probability that a frequently recurring group of characters, which has since proved the key to the whole system of writing, as well as to the language, must answer to the word *king*. Professor Lichtenstein of Helmstadt made a much bolder, and proportionably unsuccessful attempt, in his *Tentamen Palæographiæ Assyriacæ*, 1803. Having persuaded himself, from the supposed analogy of the Aramæan alphabets, that the cuneiform inscriptions must be read from right to left, and that the language must be nearly allied to the Chaldee of the Targums, he proceeded to give a translation accordingly.

ingly. A monument in cuneiform characters, found at Takkesra, near Bagdad, and published by Millin, (*Monumens inedits*, i. p. 58.) he interpreted as a *nænia* or funeral dirge, and gave a Latin translation of it; I need hardly say, with no better success than the author, who professed to have discovered a version of the 100th Psalm, in the hieroglyphics of the Portico of Dendera. Lichtenstein, applying his alphabet to the Babylonian bricks, read some of their inscriptions into passages resembling the Koran, and hence concluded that they were all of later origin than the time of Mahomet.

Grotefend, Professor in the Gymnasium of Frankfort on the Main, returned to the more cautious methods of Tychsen and Münter; and to him we owe the first complete analysis of the alphabet, and the first successful attempt to read the inscriptions into the words of a known language. No separate work has been published by him, but in 1800 a paper was read before the Royal Society of Göttingen, entitled "*Prævia de Cuneatis, quas vocant, Inscriptionibus Persepolitanis legendis et explicandis Relatio**." I do not know whether it has ever appeared in their *Commentarii*, but an account of it may be found by Silvestre de Saçy, in the *Magazin Encyclopedique*, 1803, p. 438; and by Saint Martin, in the *Journal Asiatique*, February, 1823. Both these eminent orientalists concur in Grotefend's explanation; M. St. Martin has corrected him in some minor points, and interpreted some other monuments upon the same principles. Grotefend has given a pretty full detail of the manner in which he arrived at his conclusions, in an Appendix to the *Ideen über die Politik, &c.* of Heeren, Professor at Göttingen, 1815. It will be interesting to follow his steps, and to observe how a process purely tentative has led to results, satisfactory from their harmony with each other and their accordance with all attendant circumstances, and confirmed by independent authority. The inscriptions on which he made his experiment are found in the second volume of the French translation of Niebuhr, pl. xxiv., and are marked there B and G. It must be observed that all the inscriptions at Persepolis in the cuneiform character are *triple;* that the sense is the same in each is evident, because the groups of characters correspond, though the principle of combination of the arrowheaded strokes is different, and probably the language is so. Grotefend's explanations apply only to the first, in which the words are distinguished from one another by an oblique character, and which he concludes to be the oldest, as it takes up much more room than the others.

* An abstract of Prof. Grotefend's paper will be found in the Phil. Mag. vol. xv. p. 85.—Edit.

I have already mentioned that Tychsen and Münter had pointed out a group, which they conceived to stand for *king*, but without deciding in what language. That such a title should be found in the inscriptions was *à priori* highly probable; they are always placed above or beside the two large figures which are seen on the walls of Persepolis; and every thing about these figures—their colossal size, compared with other human figures, the flyflap and umbrella, their sitting posture, while others are standing or bowing—all conspire to prove this. Another circumstance led to the same conclusion. At Nakshi Rustam near Persepolis, and at Kirmanshah, are figures of the kings of the Sassanian or second Parthian dynasty, with inscriptions, which being accompanied by Greek translations were readily deciphered by M. de Saçy (*Mémoire sur diverses Antiquités de Perse*, Paris, 1793), and were found to consist of the names of the sovereigns and their fathers, along with the title *king of kings*, and some other of those laudatory epithets in which the sovereigns of the East have in all ages delighted. The Achæmenidæ, we know, affected the title *king of kings* as much as their successors, and therefore it was antecedently probable that an inscription, evidently relating to royal personages, should contain it. Now in Niebuhr's inscription G, the group supposed to denote *king* was immediately followed by the same group, with four additional characters at the end, which were naturally supposed to express the modifications of number and case, so that the two together would be *rex regum*. The same group occurs yet a third time in the same inscription, with another very slight modification at the end; and it could hardly be doubted that this stood for *regis*. The word, therefore, which precedes this must be the proper name of a king: but this very same word begins the other inscription B. Hence it was probable that the inscription G also began with the proper name of the king, and that as the names of both occurred in it, it declared their relation to each other. The Sassanidian inscriptions referred to before, declare whose son the monarch was whose name they record, and the Persepolitan inscriptions might be fairly presumed to do the same.

But who were these kings? Cyrus could not be one of them; for if he built any palace, it was at Pasargadæ, not at Persepolis; and Cambyses being his son, had they been the two kings in the inscription the names would probably have begun with the same letter, which is not the case. Cambyses, indeed, after his conquest of Egypt, sent artists thence to build the palaces of Susa and Persepolis (*Diodorus Sic.* i. 46.), but Cambyses was succeeded by Smerdis the Magian; and it is in the highest degree improbable that he should have built a palace, during the year

year that his precarious usurpation lasted, or that his name should have remained inscribed among the legitimate monarchs of Persia. The name of Artaxerxes appeared too long for the characters of the inscription, and hence Darius and Xerxes were fixed upon as the most probable. It was obviously in favour of this supposition that in the group assigned to Xerxes, the second letter was the same as the sixth, and the fourth the same as the seventh. The final *s* in Xerxes was rejected, as being probably a Greek termination, and the *x*, as a double letter, resolved into *k* and *sch*, and thus the whole was read Kschharsha or Kschhêrschê*. The correctness of this ingenious analysis has since received confirmation in a very remarkable and unexpected manner. When M. St. Martin was engaged in the study of what Grotefend had written, it occurred to him that an alabaster vase in the Royal Library of Paris, of which an engraving had been published by Caylus in his *Recueil d'Antiquités*, vol. v. pl. 30, exhibited an inscription in Persepolitan characters, and also in hieroglyphics, and he inspected it in company with Champollion. His discoveries were even then sufficiently matured to enable him to read the name in hieroglyphics, which is surrounded with that oval ring which always incloses royal names, into *Kschearscha*. The only error committed by Grotefend was, that he read the third letter as an *h*, instead of an *e*. The name of the son being thus fixed, that of the father must be Darius. Several letters of his name were indeed ascertained by their identity with those of Kschearscha. It is written *Dareiousch**. That the *os* of the Greek name is not a mere termination, is evident from the word being spelt דריוש (*Dariosh*) in Hebrew. The same remark may be made of the *os* in Kuros. The buildings of Persepolis were therefore probably begun, or the oldest part of them completed, in the reign of Darius. And if we consider that the workmen were not sent from Egypt till Cambyses had accomplished the conquest of that country, and that he died, after a reign of only seven years, almost immediately on his return, we shall not wonder that he had no time to execute any thing at Persepolis; and that consequently Darius is the first king whose name appears there. The remaining buildings were probably erected by Xerxes.

Hitherto all that had been done was to *decipher* proper names; an attempt was next to be made to *read* some of the words, and ascertain what they meant, and to what language they belonged. The group of characters which I have so often mentioned, as probably standing for *king*, was observed to begin with the same two letters as the name which had been read *Kschearscha*; if therefore it really meant *king*, a word

* See Plate III. fig. 2.

must

must be found, in a language likely to be used in a Persian inscription, having this meaning, and beginning with these letters. Many circumstances determined Grotefend to make the attempt in the Zendic language. The Zendic is the old language of Media, and probably of Bactriana, the original seat of the Zoroastrian doctrines. It derives its name, from being that in which is written the oldest part of the Zendavesta, or "living word," the title which the worshipers of fire give to the collection of writings which they attribute to Zoroaster. M. Anquetil du Perron had brought these writings from Surat to Europe in 1762, and had published a translation of them, and a short Grammar and Lexicon of the Zendic language. When his work first made its appearance, much prejudice was excited against him from the gasconading tone in which his own adventures and merits are spoken of, and the petulance with which he attacked some eminent orientalists; and Sir William Jones published a letter to him (*Lettre à M. A*** du P***** Works, vol. x. p. 403.) in which he not only treats him personally with great severity, but even intimates that he had been imposed upon by a recent forgery of the Guebers. His own residence in the East, however, and his acquaintance with a learned Parsee, induced him to alter his opinion; and in his Discourse on Persia (Asiatic Researches, vol. i. p. 187.), he pays a tribute to the merits of Anquetil, and argues from the close affinity between the Zendic (which he considers as the most ancient language of Iran), and the Sanscrit, that a colony had passed from the one country to the other in very early times*. That the Zendavesta in its present form should be the work of Zoroaster, is not at all necessary to our using it as the most ancient monument of the Median language; of this we have a strong argument in the circumstance that part of it exists in a Pehlevi translation. Now as the Pehlevi, which is a dialect much mixed with, if not radically Chaldee, prevailed in the Parthian times, we must conclude the Zendic to be considerably older, and therefore at least as ancient as the times of the Achæmenidæ, if not prior to the existence of a Persian monarchy. This language is remarkable for the length of its forms, and the multitude of its vowels, and thus corresponds very well with the appearance of the inscription, in which the words are long, and the vowels evidently written at length, not left to be inserted in pronunciation, as in the Aramæan languages. In the Zendic then Grotefend sought the word for *king*, and found it to be *Kscheio* (whence in modern Persian *Shah*); and according to the alphabet which his deciphering of the proper names had given

* See Phil. Mag. vol. xi. p. 265, 266.—Edit.

him,

him, he read the group which follows the names of Xerxes and Darius, Kschehioh, which begins with the same two characters as Kschearscha*.

I shall not pursue any further the steps by which Grotefend and St. Martin conceive that they have attained the meaning of other groups, because I think them more doubtful; but I will give here from the latter author a translation of the two inscriptions. The first (Niebuhr B.) runs thus:

> *Darius, rex potens, rex regum, rex deorum, filius Hystaspis (Vyschtasp. St. M., Goschtaspah Gr.) generis illustris et excellentissimus.*

The second (Niebuhr G.)

> *Xerxes, rex potens, rex regum, filius regis Darii, generis illustris.*

No attempt, I believe, has been made to decipher any of the longer inscriptions which are found at Persepolis. M. St. Martin has found one at Murghâb near Persepolis, in which the name of *Ochus* occurs; and Grotefend reads that which Morier found at the same place, and of which he has given a copy, (Travels in 1810, &c. pl. xxix.) "*Dominus Cyrus rex, orbis rector.*" If this be correct, there can be no doubt that Murghâb is the ancient Pasargadæ, built by Cyrus as a memorial of the victory by which dominion passed from the Medes to the Persians, and where his tomb still remains, though now appropriated by tradition to a Mahometan saint. Murghâb lies N.E. from Persepolis; geographers have generally placed Pasargadæ at Feza, to the S. (see Sir J. Malcolm's Map), although Pliny (*H. N.* vi. 26.), having mentioned Persepolis, says, "Inde *ad orientem* Magi obtinent Pasagardas castellum." Beyond the limits of Persia more than one monument has been found with cuneiform inscriptions; I have already mentioned the stone of Tak-kesra and the Babylonian bricks; some of the cylinders which are found in such numbers among the ruins of Babylon, and which, according to the probable opinion of Landseer in his Sabæan Researches, were the *seals* spoken of by Herodotus (i. 195.) as worn by every Babylonian, have inscriptions in this character, not indeed precisely similar to the Persepolitan, but formed from the same element. In Denon's Travels in Egypt, (pl. 66. of Peltier's edition) is given a fragment of a stone found near Suez, on which is the head of a Persian king, with an inscription in the Persepolitan character, which Grotefend interprets of Darius; but being a mere fragment, and the letters having been probably cut by an Egyptian, who has placed them upside down,

* See Plate III. fig. 2.

it

it is difficult to say what the words are. Champollion has found the names of Cambyses, (*Précis*, p. 231, 2nd edition) Darius, and Artaxerxes, *hieroglyphically* written on various Egyptian monuments, but not accompanied, as the name of Xerxes before mentioned, by a Persian inscription. He has also found the name of Ramses, the Sesostris of Greek and Latin writers, written hieroglyphically and in Persepolitan characters, on a monument in Syria, near the ancient Berytus. (*Précis*, p. 272.) It will be remembered that the coast of Syria is one of the places in which Herodotus (ii. 106) declares that he had seen the monuments of this king, with an inscription commemorating the facility with which he had triumphed over the unwarlike inhabitants. I regret that Champollion has mentioned this very curious relic so briefly and incidentally; if he is right in placing Ramses in the fifteenth century before the Christian æra, how far back must we carry the use of the cuneiform character!

It was before observed that the inscriptions at Persepolis and Murghâb, and on the alabaster vase of the king of France's library, are triple. Those of the second class have been conjectured to be in the Median language, those of the third in some Aramæan dialect; but this is mere hypothesis. Whether from the language in which they are written being less full of vowels than the Zendic, or from the vowels being suppressed, or from the occasional use of monograms, they occupy less space than those of the first class. We see in them too, especially in the third class, more frequent examples of combination of the strokes, preparing the way to the Babylonian inscriptions and that of Tak-kesra, in which it is very common.

I am far from thinking that the whole of Grotefend's or St. Martin's translation of the inscriptions of the first class rests upon an equally solid foundation; but that they are alphabetical, that they contain the names of Xerxes and Darius with the title *king* in Zendic, seems to me to be established by very sufficient evidence: and even from this limited discovery very interesting consequences flow, to which I will briefly advert.

Those who have speculated on the origin of alphabetical writing have generally felt themselves at a loss to conceive, how men were led to the thought of making a visible sign the exponent of an audible impression, and thus associating two senses whose sphere and mode of operation are so different. The discoveries of Champollion seemed to facilitate the invention of an alphabet, by showing that the transition from pictural and symbolical to phonetic writing was so gradual, as not to require any subtlety of analysis or depth of reflection on the operations of mind, which it would be unreasonable to attribute

tribute to men in early times. But the Persepolitan alphabet brings back the original difficulty in all its force; it has no analogy whatever with the Egyptian system in any of its stages; it must have been formed by combination from a single elementary character; and though it exhibits the marks of rudeness in that prolixity which results from want of junction in the strokes, still it is so copious as to have, according to M. St. Martin, thirty-seven distinct characters,—a number greater than that of any alphabet, except the Sanscrit, which has fifty-two*. We must, therefore, admit that a similar result has been attained by two processes wholly dissimilar, and that the culture of the Medo-Persian empire was independent of that of Egypt. It will be no small gain to history if this discovery should check that disposition to deduce all science, art, and civilization, and even all varieties of religious belief, in the most distant parts of the ancient world, from some one centre, arbitrarily assumed, which has produced so many volumes of historical romance.

"Literas" says Pliny (*H. N.* vii. 57) "semper arbitror Assyrias fuisse; sed alii apud Ægyptios a Mercurio, alii apud Syros repertas volunt." By *Assyrian letters* he probably means the cuneiform characters: for a few lines further, having mentioned the inscriptions on the Babylonian bricks, he says, "Ex quo apparet æternum literarum usum." Now these have exclusively, I believe, cuneiform inscriptions. Nor has any monument, older than the Sassanian dynasty, been discovered in Media, Persia, or the countries on the Tigris and Euphrates, in any character but this. These then were the *Ἀσσύρια γράμματα*, in which, as well as in Greek, Darius recorded on the shores of the Bosporus the names of the nations whom he had led (Herod. i. 87), and in which the dispatches of the Persian envoy were written, whom the Athenians intercepted in the Peloponnesian war; Thucyd. iv. 50. (*τὰς ἐπιστολὰς μεταγραψάμενοι ἐκ τῶν Ἀσσυρίων γραμμάτων ἀνέγνωσαν*).

Sir William Jones in his Discourse on Persia (As. Res. i. 196.) throws out a suspicion that the Persepolitan characters, if alphabetical at all, would prove to have been used only by the priests, and to have been intelligible only to them. The priests of Egypt long laboured under a similar imputation of having locked up knowledge from the people in hieroglyphics. In both cases the charge is without foundation. We may be sure that the kings of Persia would not choose a character legible only to priests, in which to record their own praises; and in no other sense was the character concealed from the people, than that the arts of reading and writing were little diffused in those ages beyond the literary caste.

* See Phil. Mag. vol. xi. p. 265, 266.—Edit.

The Persepolitan inscriptions, even in the limited extent to which they have been deciphered, confirm the veracity of the Greek historians, attacked on very trifling grounds by some zealous orientalists. It may seem strange that any one should prefer the authority of Ferdousi, a poet of the eleventh century after Christ, abounding in the wildest fictions, to the testimony of Herodotus and Thucydides; and, in their persons, to that of the whole Greek nation, who received their histories as authentic; yet such a preference has been given by Mr. Richardson, who in a Dissertation, prefixed to his Persian Dictionary, charges the Greeks with exalting Xerxes from a satrap of Asia Minor into a king of Persia, in order to magnify their own glory in defeating him. Even a writer of more sober judgement, Sir John Malcolm (History of Persia, i. p. 237.), insinuates that vanity led the Greeks to call their invader king of Persia, because the Isfundear of Persian history, whom he supposes to be Xerxes, never ascended the throne. The inscriptions of Persepolis furnish a decisive answer to these suggestions, which indeed hardly needed such a refutation.

Although the absolute amount of historical knowledge gained by this discovery be small, its importance will not be lightly valued by one who reflects that what has been established may serve as the basis to a much larger superstructure when materials offer themselves for its erection. Nor is it improbable that such materials should be brought to light. The Persian monarchs, we know, erected pillars with inscriptions in Greek, as well as in the character and language of their own country; and should a single such monument be discovered, by some such chance as that by which the Rosetta stone was obtained, the result might be equally important. Perhaps it is from Egypt itself, rather than from Persia, that we may expect a ray of light to break on this obscure and interesting subject. During their long occupation of that country, the Persians must have made other double inscriptions, besides that of the alabaster vase, which commemorates Xerxes; and the eager and enlightened research which is now making into the antiquities of Egypt, may incidentally solve another problem. The discovery of a cuneiform inscription, accompanied by hieroglyphics, would dispel the doubt which hangs over the subject we have been considering, and afford a beautiful example of those unperceived connections, which pervade the whole system of human knowledge, and so much enhance the value of every fresh acquisition.

Since writing the above I have seen in the Asiatic Register of the present month, December 1828, a translation of a paper by M. St. Martin, in the *Journal Asiatique*, containing an account of a discovery by a traveller of the name of Schulz,

of

of upwards of forty cuneiform inscriptions near the Lake Van, in Armenia. M. St. Martin had not fully examined them, but he had found one in the triple characters of Persepolis, containing in several places the name of Xerxes (Kschearscha) son of Darius, with the titles and qualifications, *powerful king, king of kings, king of gods, gift of Ormuzd.* The tradition of the country at the present hour agrees with the Armenian history of Moses Chorenensis, in attributing the works, of which remains are seen around the Lake of Van, to Semiramis, who is also believed to have engraved the inscriptions in question. As almost every great work within the limits of the Assyrian empire was attributed to Semiramis, this tradition implies no more than that they were of Assyrian origin; which seems very likely, with the single exception of that in which Xerxes is mentioned. It may be worth while to remark that the Greek authors do not speak of any expedition of Semiramis to Armenia; but Diodorus (ii. 13.) represents her as engraving an inscription on Mount Bagistan in Media, Συρίοις γράμμασι, on which Wesseling observes "Assyrias intelligit."

[We illustrate this article by a Plate of specimens of the nail-headed characters from the *Babylonian* bricks, which originally appeared in the Phil. Mag. (1st series,) nearly thirty years since. Mr. Kenrick having favoured us with the respective words for *Xerxes*, *Rex*, and *Darii*, as expressed at *Persepolis*, we have inserted them in the Plate, as fig. 2.—Edit.]

XLIX. *Researches on the Anatomy of the Brain. By* Dr. Foville, *Principal Physician of the Lunatic Asylum for the Department of the Lower Seine, &c.*

[Concluded from p. 286.]

Anatomical Section.

THE spinal marrow is composed of two symmetrical portions, in each of which we perceive three distinct bundles or columns; an anterior, a posterior, and a middle. On their exterior are two orders of insertion of nerves, and within each of the lateral halves which are united by a commissure of medullary matter, we find a line of cineritious matter. The size of the spinal marrow is most considerable at the upper part of the cervical portion, where it takes the name of medulla oblongata, and presents several distinct enlargements. The most important of these are the corpora pyramidalia, which decussate at the upper part, the corpora olivaria, the corpora rectiformia, and the corpora pyramidalia posteriora.

One part of these enlargements is prolonged into the brain, another into the corpora quadrigemina, and a third into the cerebellum.

The corpora pyramidalia anteriora are the only parts in which there is an evident decussation of fibres.

The cerebellum is the continuation of the corpus rectiforme, which meeting with and confounding itself with the bundle of nervous matter designated by the name of processus ad testes, and with the larger bundle proceeding from the tuber annulare, forms a mass at first somewhat rounded, but which soon expands into a fibrous plane, which extending from within outwards reaches the cineritious matter at the circumference, when expanding itself both above and below into a white and very fine layer, it lines the cineritious matter, accommodating itself to all its folds, which are applied to the two surfaces of the large plane formed by the concurrence of the three nervous bundles as already mentioned.

One part of this plane is reflected backwards from without inwards towards the median line, and with its fellow forms within the substance of the processus vermiformis a commissure analogous to the corpus callosum of the cerebrum.

Thus the three processes which constitute the crus cerebelli penetrate the medullary matter of the cerebellum, and lining it with a surface of white matter are enveloped by it as the stem of a young champignon is by its cap. Reil had already seen a part of this arrangement.

The corpora quadrigemina receive from the medulla oblongata two bundles of fibres, which are easily traced to the corpora olivaria.

Lastly, the cerebrum receives through the intervention of its crura the remaining bundles of fibres which enter into the composition of the medulla. Each crus cerebri is composed of two distant bundles of fibres. One of these is the continuation of one of the anterior pyramids of the medulla oblongata, which decussating with its fellow at the upper part, and passing from behind forwards, crosses at right angles the transverse fibres of the tuber annulare, before which they are so disposed as to form a sort of groove. The posterior bundle, of which I have next to speak, is lodged in this groove, and completes the cylinder of the crus cerebri.

This posterior bundle of the crus cerebri proceeding from the posterior part of the medulla without decussating with its fellow, passes over the superior transverse fibres of the tuber annulare on which its inferior surface rests, whilst its superior forms the floor of the fourth ventricle.

Throughout the whole extent of the crus properly so called, these two bundles, though more and more closely approximating, remain nevertheless distant, being separated by a black substance, the locus niger. They proceed nearly parallel to each other till they diverge in the corpora striata and thalami nervorum

nervorum opticorum, and form a plane of which all the rays tend towards the curved line which limits the corpora striata and thalami on the outer side.

At this point, to which we have traced the radiating fibres of the crus cerebri, we find the commencement of a different arrangement: but before speaking of this, it will be proper clearly to define whence we are to set out.

The fibrous expansion of the crus forms in the substance of the corpus striatum and thalamus a large plane directed obliquely outwards and upwards. This plane separates the cineritious matter of the corpus striatum into two nearly equal portions, of which the one rests on the superior face of the plane, and is that which we see projecting into the ventricle; the other, placed beneath the plane, is as it were lost in the mass of the hemisphere. This broad plane of the corpus striatum and optic thalamus, or in other words the expansion of the crus cerebri, presents nearly the figure of a triangle bounded by two straight lines and a curved one; the two straight lines are the two sides of the crus, the curved line is the boundary of the corpus and thalamus to the outer side of the ventricle. It is to this curved line as to a circumference that the radiating fibres of the crus are directed. This line, the imaginary limit of the expansion of the crus, we shall assume as the origin of other parts which we are now about to examine.

From this line, on the outer side, there proceed three perfectly distant planes or layers placed one above another at their origin, whence each pursues a particular course.

1*st Plane.*—The superior plane, which on account of its distinction we may call the plane of the ventricle, or the plane of the corpus callosum, arising from the curved line before mentioned, mounts on the outer side of the corpus striatum and thalamus, to which it is applied, having in the first part of its course a nearly vertical direction. It forms a slight convexity outwards, and then bending inwards horizontally towards the median line, unites with its fellow, with which it concurs to form the corpus callosum.

Thus the corpus callosum as a whole represents a roof, of which the sides proceeding from the plane of the corpus striatum and thalamus are continuous with the crura cerebri, and have nothing to do with the hemispheres properly so called. In other words, the corpus callosum is a true commissure of the crura cerebri. But do its fibres pass from one side to the other across the median line? Is there upon this line an anastomosis of fibres? These are questions to which my examination of this part have not yet enabled me to reply.

2nd Plane.—Immediately beneath the plane which we have just examined,

examined, and from the same line, is separated a second plane, which from its destination we shall be warranted in calling the plane of the hemisphere. This plane at first ascending parallel to that of the corpus callosum, to which it is applied in the first part of its course, afterwards quits that plane where it is reflected inwards, and continuing in a nearly vertical direction, reaches the cineritious matter of the convolutions along the curved line, at which the convex external and the flat internal surface of the hemisphere meet each other; that is to say, it reaches the most elevated part of the hemisphere along its whole length.

Both to the inner and the outer side of its insertion this plane is expanded beneath the grey matter which it lines in the form of a white layer, of which the fibrous structure is not nearly so evident as is that of the plane itself. This expansion follows all the folds of the gray substance, and conjointly with it, constitutes the convolutions which are applied to the two surfaces of the plane of the hemisphere.

When this plane is examined on its upper surface, we see fibres, of which all the bundles radiate towards the circumference, where they are inserted, and converge towards the expansion of the crura, of which its fibres are evidently the continuation.

3rd Plane.—Beneath this plane of the hemisphere, but still arising from the same line, there proceeds a third plane, of less extent than the two preceding, and taking quite a different direction.

This plane, immediately after its emersion from the origin common to it and to the two first-mentioned planes, descends to the outer side of the inferior half of the gray substance of the corpus striatum, invests it below, and advancing inwards meets the corresponding plane from the opposite side, and ascending in juxta-position with it on the median line forms the septum lucidum of the ventricles.

It is not all the fibres of this plane which go directly to the septum lucidum. A considerable portion pass backwards, of which some form an expansion belonging specially to the temporal lobe; whilst others reach the large extremity of the cornu Ammonis, and becoming continuous with the corpus fimbriatum, pass into the fornix, and thus form another communication with the septum lucidum.

I have too much consideration for the time of the Academy of Sciences to allow myself to enter more minutely into anatomical details, and now proceed to the examination of the combination and mutual relation of the parts, to the consideration of which the preceding facts naturally lead.

If

If when we have separated all the planes, so as to see their reciprocal relations, we make a transverse vertical section of the brain at that part which corresponds to the coronal suture, we may observe at the centre of this section a surface of two inches in diameter, which nearly resembles the section of a cylinder. The circumference of this cylinder, which is slightly hollowed both above and below, is entirely composed of medullary matter. About the middle of its thickness we see on each side a large white surface, above and below which are two gray surfaces. The planes of the hemispheres extend to the right and left from the sides of this cylinder, and do not exceed two lines in thickness.

If we compare this section with a transverse section of the spinal marrow, we cannot help being struck with the remarkable analogy which exists between the spinal marrow and the central part of the brain.

In both, the external part is extremely white; in both there are four gray surfaces separated by medullary matter, the proportion of which it is true, differs, in the two cases, but the analogy is preserved in the arrangement. Lastly, the nerves which rise from each side of the spinal cord are represented by the plane of the hemispheres, which we may consider as a series of nerves in close apposition.

This analogy is by far the most striking when the comparison is made with a section of quite the upper part of the spinal cord of an infant.

An important observation may be made with the brain of a child of two or three years of age. A transverse vertical section at the part opposite to the coronal suture displays the arrangement above described. Simple but well-defined white lines mark the central cylinder, analogous to the spinal marrow, and indicate the course of each of the three planes, which are not to be distinguished in the adult brain until they have been artificially separated.

Physiological Section.

It follows as a consequence of the single analogy which I have pointed out, that to the central part of the brain must be attributed functions analogous to those of the spinal cord, and that the outer parts of the brain must be regarded as devoted to the special functions of the brain itself.

The plane of the hemispheres being analogous to the spinal nerves, will in this view be regarded as the medium of reciprocal communication between the central and the circumferent parts of the brain.

These physiological conjectures, which we have noticed as simply

simply resulting from anatomical structure, acquire a vast additional importance when they are taken in conjunction with innumerable facts, which prove that the derangements to be observed in the brains of those who have laboured under mental alienation (without complication), are constantly to be found on the surface of the organ, that is in the cineritious matter of the convolutions. At the same time it is generally known that those diseases of the brain which more particularly affect motion, have their seat in the median or internal parts. These observations obviously support the analogy which I have pointed out as existing between the brain and the spinal cord.

I must not allow myself to enter into longer details on this point, but proceed to consider the influence which the knowledge of this anatomical structure of the brain may have on the pathology of this organ.

Pathological Part.

It is evident that the better we are acquainted with the structure of an organ in its healthy state, the more capable shall we be of appreciating the alterations which it may undergo. In other words, healthy anatomy is the true basis of morbid anatomy. The observations which I have collected show the importance of this general truth, in relation to the brain in particular.

The separation of all the planes of which I have spoken is easily effected in healthy brains. In young children they may be said to be simply in juxta-position. We may remark in the interval between them a thin layer of very fine, extremely soft, and highly vascular cellular structure, which is probably a continuation of the vascular membrane at the exterior of the brain.

In the healthy brains of adults these planes are more intimately united together; but their separation may always be easily and neatly effected if we proceed with care. This is by no means the case in many diseases of the brain. I have often in vain attempted to separate the planes. They were as intimately adherent as the pleura pulmonalis to the pleura costalis after inflammation of the surfaces; and the attempt to separate them had invariably the effect of tearing them.

How was this alteration to be recognized when the structure on which its existence depends was unknown; and how often, from this very cause, have diseased brains been examined without the slightest trace of derangement having been discovered?

But I must suspend these very summary considerations, which I have brought forward rather to set forth the advantages

which

which may accrue to the science of medicine from a more exact knowledge of the anatomy of the brain, than to make known those which I have myself derived from it.

Recapitulation.

The crus cerebri is composed of two bundles of fibres expanded in the corpus striatum and thalamus nervi optici into a larger plane, which radiates from the crus, taken as the centre, towards the hemisphere regarded as the circumference. This plane, which we may consider as the origin of the different parts which follow, is divided into three secondary layers or planes, having an arrangement which may be compared to three petals of an Iris held together between the fingers, two of the petals turning their concavity upwards, and the third turning its concavity downwards.

The superior of these planes forms with its fellow the corpus callosum, which may be regarded as the commissure of the crura. The middle plane belongs exclusively to the hemisphere, and the inferior belongs to the septum lucidum, the temporal lobe, and the cornu Ammonis.

The central parts of the brain present in their structure a striking analogy to the spinal cord, and, as I believe, ought to be considered as its superior termination; an opinion which has already been adopted by many authors.

The plane of the hemisphere I consider to be analogous to the spinal nerves; and the cineritious matter of the convolutions I regard as constituting the essential part of the cerebrum.

These anatomical data appear to lead to several physiological probabilities, which pathological observations appear to confirm.

Finally, I conceive that the knowledge of the structure of the brain, such as I have pointed it out, may be found of real advantage in the detection of the morbid alterations of which this organ may be the subject.

A. Foville.

[This Memoir was presented to the Institute on the 24th of March 1828.]

After the analysis the Report proceeds.—The principal fact which the author brings forward, and which tends more and more to prove, that within the assemblage of the vertebræ of the head, the nervous system is composed of a central part, the prolongation of the spinal marrow, and of ganglia; and further, that the crus cerebri is composed of three planes or orders of fibres, one of which passing inwards forms the corpus callosum, appears to us to be placed beyond a doubt, at least with respect to the human subject. We must, however, confess

that we have not been able to see so clear a demonstration in the brains of some of the mammifera which we have examined*.

We are thus compelled on this point to renounce the opinion of Drs. Gall and Spurzheim, who consider the corpus callosum as composed of converging fibres, and forming the commissure of the two hemispheres. We may assure ourselves of the state of the case by a very simple process. It consists in separating the two hemispheres from above, and gently passing the finger under the edge which the flat vertical surface presents to the corpus callosum, into what has sometimes been called the ventricle. We thus readily arrive at the line of separation between the two upper planes, one of which passes inwards, and the other vertically upwards, into the hemisphere. It appears to us, however, that it is impossible to make this separation without some rupture taking place between the two parts; but this may possibly depend on strong adhesions occasioned by the disorganization of the membrane of separation. We may likewise easily show these different planes by making the vertical section above described, opposite to the situation of the coronal suture, through the brain of a young infant. We may even perceive between the two inferior planes a trace of cineritious matter, pointing out their separation; and by merely blowing on them at this part, we are sometimes able to effect their detachment from each other.

We consider this part of Dr. Foville's paper as worthy of the utmost attention of the anatomist. We think that the idea of regarding the middle plane of the crus cerebri as analogous to the nerves of the spinal marrow, and as losing itself in the cineritious matter of the convolutions, is happy, and in harmony with what we know of that part of the ganglionic nervous system which is furnished with external apparatus. It is also corroborated by the anatomical observations of Dr. Foville.

It appears to us that the course which this anatomist has taken is the only one which can lead to any certain results; since he makes his anatomical and pathological researches keep pace with each other, and has already begun to systematize some parts in the anatomy of the brain, in conjunction with its functions both in the state of health and disease. In this attempt he has, perhaps, been more successful than any one who has preceded him.

But as we know that this anatomist has already obtained an insight, perhaps equally interesting, into other important

* Since this Report was written, I have had the advantage of seeing the brains of several of these animals examined by Dr. Foville; and with the precautions which he had then employed, the existence of the three planes was most readily and satisfactorily shown, although, as Blainville remarks, this point was at one time not so easily effected.—T. H.

parts

parts of the cerebral portion of the nervous system, and as this system requires to be studied as a whole, in order to confirm the particulars which may have been discovered, we shall confine ourselves to the recommendation, that the Academy strongly encourage Dr. Foville to pursue his researches with caution, and to avail himself of the light of comparative anatomy; and that he be advised not to hasten the publication of any observations, until they appear to himself to be placed completely beyond doubt, and to be susceptible of the most rigorous demonstration. They serve science poorly who encumber her with ill-prepared materials, however copious and specious they may be.—These considerations alone have diverted us from a conclusion in favour of publishing Dr. Foville's Researches on the Brain, so far as they have been communicated to us, amongst the collections of the Academy, of which they appear to us perfectly worthy, on the double ground of their own interest, and of the good faith with which they have been brought forward.

(Signed) Dumeril, and
D. de Blainville (the Reporter).

Certified as a true copy, G. Cuvier,
Perpetual Secretary, Counsellor of State, &c.

L. *A Sketch of the Topography and Geology of Lake Ontario. By* J. J. Bigsby, *M.D. F.L. and G.S., For. Mem. Amer. Phil. Soc. &c.*

[Continued from page 274.]

THERE now succeeds the stratum, which by way of eminence, Mr. Eaton denominates the *Saliferous Rock.* It is itself very much the same as the English stratum; but the sandstones directly above it differ in containing a large amount of iron. I am inclined to consider this rock, the ferriferous slate and sandstone of Mr. E., his calciferous slate and the geodiferous rock, to belong to the same formation,—that producing the salt. They are all conformable to each other. I know that many, and I believe that all of them, run into each other. The ferriferous slate and sandstone sometimes alternate. The geodiferous rock abounds in gypsum; but not by any means so extensively as the calciferous slate. In the saliferous group which I have instituted, the gypsum occupies here the upper beds as in Europe. Their whole thickness is by no means equal to that of the red marl of England, its supposed representative*.

* At p. 138 of our present volume will be found a different arrangement, by Mr. Featherstonehaugh, of the formations which appear to be the equivalents of Mr. Eaton's series.—Edit.

Saliferous Rock of Mr. Eaton is an aggregate of minute rounded grains of quartzose sand, simply, or mingled with argillaceous, so forming red or greenish sandstone, or soft red or greenish brittle clayslate. The sandstone kind is distinguished from the old red sandstone by its rounded grains, as they appear under the magnifier, and by its not containing glimmering scales, except in rare cases.—(G. S. p. 35.)

"From near Little Falls to the west end of Lake Ontario, this rock may be traced in the most satisfactory manner. It is about 250 miles in length*, and something more than twenty miles in breadth on an average (on the south shore of Lake Ontario exclusively). Its thickness, where it crops out in Steel's Creek, and some other places, will average about eighty feet. But a Mr. Bennett bored into it 140 feet, from the bottom of Oak Orchard Creek, seven miles south of Lake Ontario, and did not reach its lower surface. At and below the Genesee Falls, and at the mouth of the Niagara River, a thickness about equal to Mr. Bennett's boring may be seen, without any evidence of a near approach to its next underlaying stratum.

"This rock is manifestly the floor of all the salt springs of the canal district. It descends like an inclined plane to the Genesee River, where it is about 250 feet lower than at the ridge between Little Falls and Utica, where it crops out and terminates. From Genesee River westerly it is an ascending plane. It rises up to the canal level eight miles west of that river; though where it crosses the river on the same level, the upper surface of the rock is considerably more than one hundred feet below it. This difference, however, does not depend wholly on the general western ascent of the rock; for it also ascends as it recedes from the lake. To have a correct conception of the form of this rock, we must view it as the southern side or brim of the great elliptical basin which holds the waters of Lake Ontario."—(G. S. p. 103, 104.)

"Beginning at its eastern limit, where it crops out, near Little Falls on the Mohawk, we find no salt springs within about twenty miles.

"Throughout this twenty miles, the rock is mostly of the red sandstone kind, and more coarse and harsh than it is further west. But near Vernon Centre, seven miles south of the canal, where the first salt spring occurs, the red slate appears with the red sandstone in considerable proportion.

"This spring issues from the upper surface of the rock on the west side of Skanando Creek; whose banks consist of the soft red saliferous slate, beautifully spotted with nodules of green slate, resembling the ferriferous slate.

* Meaning, as visible here; for it extends throughout the Basins of Lake Erie and Mississippi.

"The

"The next spring which I saw is about nine or ten miles west, on the lands of Sidney Breese, Esq. There is another in the same direction in Lennox, and about the same distance from the last. The descent of the rock is very uniform along the line of these springs, and also all the way to Salina or the Onondaga spring. The springs further west, as Montezuma, Clyde, &c. are still deeper; probably in the same ratio. Beyond the Genesee River they are more elevated, according to the ascending course of the rock. The descent of this rock in a north direction towards Lake Ontario is not uniform. It falls away by offsets, like the grauwacke of Cattskill Mountains; differing greatly, however, in degree. The edge of the principal offset forms a kind of ridge whereon a road is constructed, called 'Ridge Road.'"—(G. S. p. 104.)

"We have a most excellent view of this saliferous rock, with the five next strata above it, in Genesee River near Rochester; in Irondiquet Creek, four miles east; throughout the whole extent of the south shore of Lake Ontario, at short intervals, and in the chasm of Niagara River. It is also brought into sight by the disintegration of the overlying ferriferous rocks at intervals from Little Falls to Oneida Creek, within a breadth of ten miles south of the canal."—(G. S. p. 108.)

Mr. Eaton states that with ample opportunities of discovering any rock salt by borings, ravines, &c., none has been found; and he thinks that the brine is produced from elementary materials contained in this and the higher rocks (p. 109).* He believes that the salt is diffused through the whole of the strata; but that the strongest waters are at the bottom, as has been verified at Salina and Oak Orchard Creek. At the latter place the rock was bored to the extent of 140 feet, when the conglomerate was found below it.

A specimen of the dry salt of Salina, analysed by Dr. M^c^Neven of New York, furnished, 93·194 parts of muriate of soda, 2·525 sulphate of potash, 2·269 of muriate of lime, and 2·412 of muriate of magnesia.

No rock salt is found in any of the muriatiferous formations of North America, excepting those of California.

Grayband.—A single stratum of trifling thickness, which rests upon the saliferous slate, has received a separate name (as above) from Mr. Eaton. Its only title to such distinction is its extent. It evidently belongs to the salt formation, like a similar layer at Runcorn and Manley in Cheshire. (Geological Survey of England, Conybeare and Phillips, p. 280).—Mr. Eaton describes it as a hard-grained gray homogeneous

* See also Silliman's Amer. Journ. of Science, vol. vi. p. 242.—Edit.

rock.

rock. It is a thin stratum, but continuous for 200 to 300 miles. It is four feet thick at Genesee Falls, eight feet at Niagara River, twelve feet on the creek east of Lockport, and fifteen feet at most places, where it crops out with the saliferous rock, near the Mohawk. It varies considerably, however, in its texture and its constituents. In some places it seems to be considerably argillaceous; in others, quartzy; and in others again, it contains considerable carbonate of lime.—(G. S. p.115, 116.)

Above this grayband are placed conformably two sets of strata abounding in iron ore. The lowest of these Mr. Eaton names

Ferriferous Slate, describing it as soft, almost homogeneous, argillaceous, greenish-blue and bluish-green; a brittle, generally a shaly slate.—(P. 36.)

This rock is seen frequently in connection with those above and below it: its thickness is variable. At the Genesee Falls it is twenty-three feet thick, perhaps the average. It is but ten feet thick at the Verona Iron Mines. It runs about two miles and a half south of Lake Ontario, from Irondiquet's Bay to Sodus Bay. The iron ore is mostly the argillaceous oxide, sometimes passing into the jaspery variety. The best kind is the lenticular. It being the peroxide of iron combined with alumine, the colour is bright red, and it is of a soft texture. Some specimens may be rubbed into a fine powder between the fingers. It has an unctuous feel, and stains the hands deeply and permanently. Though it will generally give but 30 per cent of iron, it is so easily reduced that it is a very profitable ore. "The jaspery variety is hard, and difficult to reduce. It is not at present used at the furnaces. Sometimes the ore is in a distinct bed or layer between the two ferriferous strata. It is more commonly attached to the upper surface of the slate, and intermixed with the layers of sandstone. Sometimes it is embraced between layers in both rocks. In the banks of Genesee River, at the Falls, it appears like a distinct stratum between the two rocks. It has the same appearance in some other places. It is so remarkably continuous, that there would perhaps be no impropriety in calling it a stratum of argillaceous iron ore. I have seen it between, and in the adjoining parts of, these rocks, at frequent intervals from near Little Falls to Queenston in Canada, a distance considerably exceeding two hundred miles. It is never wanting in the canal district, where the ferriferous rocks are present.

"The whole thickness of the iron formation at Genesee Falls is thirty-eight feet. Here the iron ore is but one foot in thickness. In most of the ore beds which are wrought, the ore is twelve to twenty inches in thickness. In several localities

lities I have seen two or three beds in succession alternating with layers of the sand rock; rarely with those of the slate rock. The best ore beds (or perhaps, more properly, the best parts of the great stratum of argillaceous iron ore) which are at present wrought are between Little Falls and Oneida Creek on the south side of the canal, and between Lyons and the Genesee River on the north side." West of Genesee River, the iron formation is chiefly on the south side of the canal as far as Lockport*.

Ferriferous Sand-rock is the other stratum, so characterized by Mr. E., from its abounding in iron. He defines it to be "a gray or yellowish gray massive aggregate of quartzose grains, often hyaline, and without cement.

This stratum is fourteen feet thick at the rivers Genesee and Niagara; but at the out-croppings of these two rocks near the Mohawk, and wherever their full thickness is in view, almost to Vernon, the sand-rock is five to ten times the thickness of the slate. This rock is hard, breaking into thick shapeless or square-faced blocks. In some places the two rocks alternate with each other, but generally they are separated by a continuous layer, or extensive bed of argillaceous iron ore."—(P. 120.)

"The ore embraced in this rock is more granulated, and has less the appearance of the lenticular form than that which is between it and the slate, or embraced in the slate. More of the jaspery variety is found in it; and sometimes the oxide of iron is in larger proportion, compared with the alumine, than is found in connection with the ferriferous slate-rock."

Calciferous Slate of Eaton next follows. It is "an aggregate of quartzose sand and clay-slate, or other aluminous compounds. Sometimes it is a soft thin slate; but it is often hard, siliceous, and rings more or less on being struck. It is of a gray colour, and can scarcely be distinguished from grauwacke slate in hand specimens with the naked eye. But under the magnifier the constituent particles appear somewhat rounded; and it is nearly or quite destitute of the shining scales."—(G. S. p. 37).

This position of this rock is seen very clearly in numberless places, and throughout the whole district now under discus-

* "In the bottom of a well in Salina, at the upper part of the village, forty-three feet deep, this rock presents a very singular structure. The surfaces of the layers, which are about half an inch thick, are marked with angular grooves, so arranged as to resemble the mid-ribs of leaves, with lateral secondary ribs and veins. These appearances are undoubtedly the effect of a crystalline tendency. They may be compared with the crystals of frost on a glass window."—G. S. p. 119.

sion.

sion. It is chiefly visible on the south side of the canal. It appears at Genesee River near Rochester; at Lockport on the canal, and in the great chasm of the Falls of Niagara. Its thickness is variable; from Oneida to Palmyra (140 miles) it is 100 to 250 feet thick, and is fully displayed in this interval. It contains numerous beds of gypsum, and of limestone with shells. As an example of this, Mr. Eaton adduces the neighbourhood of Limestone Creek in the township of Manlius. He here "immediately on the ferriferous formation found this slate; then a bed of gypsum terminating east and west in the bank of the canal, being eight to ten perches in length; above the gypsum the slate is continued to about the thickness of sixty or seventy feet: then an extensive bed of shell-limestone occurs, ten to twelve feet in thickness, and perhaps from half a mile to a mile in breadth; then the slate again, embracing a bed of gypsum of much greater extent than that in the immediate bank of the canal. This last-mentioned slate, with its bed of gypsum, terminates the hill upwards."—(G. S. p. 126.)

The imbedded limestone is in several forms: one, which is dark gray or blue, is perforated everywhere with curvilinear holes, some being still lined with a tubular calcareous crust. The rock in the intervals of holes is very compact. Another common form is siliceous; quartzose and calcareous grains finely comminuted, being all that is essential. It is called "water lime-rock," from its property of hardening under water when used as paste or mortar. In some places it passes into a cellular sponge-like rock, and scarcely contains any carbonate of lime. It then generally abounds in petrifactions.—(P. 127.)

The calciferous slate is remarkable for its spontaneous and almost universal production of Epsom salts, alum, and copperas. Stalactites of the carbonate of lime, from a quarter to three inches in length, are common on the under surfaces of its thin slaty layers. Vast beds of calc tuff are also produced from it.

The above account of this rock is wholly that of Mr. Eaton. He also affixes to it a second appellation, "Second grauwacke with shell lime-rock."—I have already objected to this name. Nearly all the rock, as I have seen it at the Genesee Falls, Lockport and Niagara, is strictly an argillo-calcareous shale, in very thin brittle leaves, effervescing freely on exposure to acids; black, homogeneous, of dull lustre, and in places abounding in fossils characterizing transition limestones*. At

* Among these are two species of Caryocrinites, described by Mr. Say in the 4th volume of the Journal of the Academy of Natural Sciences of Philadelphia; and a very large and remarkable Trilobite, also described in the same volume.

the

the Genesee Falls much of it, however, is pale-brown, less schistose, earthy, and interspersed with quartzose grains;—a kind of compound sandstone not to be distinguished in hand specimens from real grauwacke slate in its finer varieties.

Geodiferous Rock,—a fetid, often very massive stratum of limestone, usually very dark-coloured, but sometimes light gray, is only met with in the western half of Lake Ontario. It is distinctly seen to rest upon, and moreover to pass into the last-described rock,—a fact which Mr. Eaton has not mentioned. At the Genesee River near Rochester, it is thirty feet thick, at Lockport fifty, and at Niagara seventy. (G. S. p. 135.) "Though this stratum is generally a very pure carbonate of lime, mostly a dark-coloured formless rock, yet in many respects it resembles the gray siliceous transition sandstone, which I have described under 'calciferous sandstone.'" They both contain geodes of quartz crystals, calcspar, and sulphate of zinc. This contains sulphate of strontian; that sulphate of barytes.—(G. S. p. 135.)

In this limestone Mr. Eaton finds "snowy gypsum, selenite, dog-tooth spar, pearl spar, fluor spar, waxy zinc blende, sulphate of strontian, and quartz crystals."—(P. 134.)

For further particulars respecting this rock, *vide* "Geology of the River Niagara," speedily to be published.

The two rocks next succeeding in Mr. Eaton's series are the "Cornitiferous" and "Pyritiferous Lime-rocks," of which I shall here say very little; as they belong to the River Niagara and Lake Erie. The first is essentially the same as the geodiferous, but is full of chert in nodules and layers. The second is a siliceous or calcareous rock, with an aluminous cement, and abounding in iron pyrites. Mr. Eaton considers it to be the equivalent of the pyritous shale of Whitby and Charmouth, a member of the lias formation. It is visible on the south side of Lake Ontario, but at some distance from it, from Onondago salt-springs to Lake Erie, 150 miles.—(P. 145.)

The rocks of the north shore of this lake are by no means so fully nor so frequently brought into view as those of the south shore, which have now been described.

I have no doubt that, as far as they go, they are parts of the same series; but excepting the two lowest, they occur in such very small and distant patches, on the same level, and so much weathered, that to assign their geological relations is a very hazardous attempt. The salt formation certainly exists throughout its whole extent; but though I have carefully examined the greater part of the north shore (180 miles) in a boat, and passed more than once at great leisure, by land, from Kingston to York, visiting the middle parts of the rivers Trent

and Moira; and crossing the height of land from this lake to that of Simcoe, I never could either see or hear of the muriatiferous rock itself. At the west end of Ontario, and throughout the eastern part of the Niagara district, it emerges in the ravines and beds of streams. Of the rocks above this, I have only seen what I consider to belong to the calciferous slate. Beginning with the lowest, I shall now give a short but sufficient sketch of the rocks of this shore in succession from the north-east, including also those of its outlet.

Mr. Eaton found, inclining upon the gneiss of Macomb's Mountains, calciferous sandstone: on that of the Thousand Islands and of the vicinity of Kingston, there is no such stratum; but in place of it, from Brockville to seven miles above Gananoque (forty-nine miles), there is a hard quartzy sandstone in thin layers placed horizontally or nearly so. From three miles to ten miles above Brockville, it forms on the north side of the outlet extremely picturesque cliffs surmounted by green slopes, through whose herbage the gray rock occasionally peeps. Seven miles from the above town, on the same side of the river, two mounds of fine granular gneiss, within a few feet of each other, make part of the precipice without disturbing the sandstone in close contact with it. The interval between them has formed into a shallow cave. The sandstone is most plentiful on the east side of this primitive barrier; and in the interior, a few miles west and north-west of Brockville, it appears among the gneiss mounds as the precipitous sides of valleys, and as obstructions to water-courses.

This sandstone, both in large tracts, and in alternating layers of the same cliff, is gray and white, rarely spotted with carburet of iron. It is granular, fine and coarse, and occasionally contains nodules of crystalline quartz from the size of a mustard-seed to that of a child's head. These nodules are seen in irregular and sometimes thick beds at the lower parts of the stratum, on the river side, from four and four and a half to seven miles above Brockville. Here they are not of milky quartz, but are hyaline, or brown with iron, in which case the imbedding sandstone is also brown. At Gananoque this rock forms a natural quay for commercial purposes. Here the larger nodules (white) are on the surface, the smaller scattered through the body of the layers. At the south-west end of this arenaceous platform there are many balls of sandstone six inches in diameter, with onion-like concentric coats, all of the same substance as the containing rock. Six miles above Gananoque, the north main shore of a strait, opposite the end of Hour Island, is composed of a pudding-stone of very large rounded masses of quartz, some of which are of the milky kind.

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They are in a cement of minute white quartzy grains. It occupies a low cliff, and is finer at the top than below, and very white. A few yards behind this is another shelf, but it is of very white and fine sandstone.

[To be continued.]

LI. *Extract from a Report made on the 29th of September 1827, on the Probability of finding Coal near Leicester. By Mr.* Francis Forster, *Mineral Surveyor, and Assayer of Coal and Iron Ore.*

[With a Map.]

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN September 1827, at the request of a person connected with coal and other mines, I made, with the assistance of my brother, Mr. M. Forster, a survey of the country surrounding Leicester, with a view to ascertain the probability of the existence of coal near that town. As circumstances have since occurred, which leave me at liberty to publish this Report, and as the opinions therein contained have also been in a great measure confirmed by the subsequent discovery of a seam of coal by boring near Bagworth (as announced in the New Monthly Magazine for July 1828, and noticed in the Phil. Mag. and Annals for March last),—I have been induced to offer an extract for publication in your valuable Magazine. Should you do me the favour to insert it, I trust that it may be found to contain hints interesting to the geologist; and I feel confident that they cannot fail to prove so to every one interested in the prosperity of Leicester.

I remain, Gentlemen, your obedient servant,

113, Aldersgate-street, London, Feb. 26, 1829. Francis Forster.

On examining the strata in the vicinity of Leicester, it was found to consist of new red sandstone or marl, laying in nearly horizontal beds, and so completely covering over and concealing the measures beneath it, that it was found impracticable to trace the basset or outbreak of any of the subjacent strata, until I reached the transition rocks of Charnwood Forest, between which, and the new red sandstone, I was aware that the coal-beds must be found, provided they existed at all. My next step, therefore, was to examine very carefully the junction of the sandstone and transition formations, with a view to ascertain whether any coal-beds, or rocks connected therewith, made their appearance, as underlaying the sandstone, at the precise points where the latter basseted or cropped

ped out upon the base of the transition hills. Here, however, I was disappointed; for in every part that came under my observation, the sandstone formed a complete junction with the transition rocks, thus effectually preventing any coal-measures which might happen to intervene, from making their appearance on the surface.

Thus circumstanced, it was judged best to abandon all further examination of the strata immediately around Leicester (from which alone the *certain existence* of coal-measures there could be established), and to commence a survey of the nearest coal-fields already known; and by tracing the direction in which such coal-fields extended, the rocks with which the coal-beds were associated, and their relative position to the transition measures and the new red sandstone, I expected to be able to ascertain the *probability* of the existence or non-existence of coal in the immediate neighbourhood of Leicester: for owing to causes already stated, I had given up all hopes of establishing the *certainty* of its being found there.

From a previous knowledge of that district, I was aware that the Warwickshire coal-field did not extend to Leicester; having seen indications of its final disappearance along its eastern boundary near Nuneaton: my attention was therefore wholly directed to the coal-field extending around Ashby-de-la-Zouch, and Cole Orton. I traced the outbreak or disappearance of this coal-field (shaded black in the sketch) in its south-eastern extremity; or in other words, on that side of it lying nearest to Leicester, which outbreak or disappearance is also shown on the accompanying sketch by the line *b*, *b*, *b*, *b* *, extending on the west of Ibstock (a village about twelve miles W. from Leicester) to its junction with the transition rocks at Thrinkston. The transition rocks are shaded purple in the sketch; and their extent to the S.S.W. and S.E. is shown by the dotted line *a*, *a*, *a*, *a*, where they are bounded by the tract of new red sandstone (shaded red) so frequently mentioned. On examining the sketch, it will be observed that the extreme visible extent of the coal-measures towards Leicester is bounded by the red sandstone on the W. of Ibstock, from which place their junction extends in an irregular line to Swannington, beyond which, at Thrinkston, both formations are terminated by a bed of limestone, which appeared to abut against the transition rocks of Charnwood Forest. The line *b*, *b*, *b*, *b*, it is repeated, shows the apparent south-eastern extent of the coal-measures of Ashby-de-

* It will be observed that the line *b*, *b*, *b*, *b* is broken by the extension of the new red sandstone towards Ashby; the exact limit of which, from want of time, I could not satisfactorily ascertain.

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n-Zouch and Cole Orton: from some unknown cause, however, probably from the intervention of a fault or dyke running from Swannington towards Ibstock, and throwing the strata down to the eastward, the coal-measures are again thrown in, and are found extending *under the new red sandstone* at a pit marked A, near Whitwick, as well as at a pit marked B, near Ibstock: at both of these places, borings have been already made to the coal; and from the similarity of the strata bored through, there is every reason to suppose that the same measures extend from Whitwick to Ibstock, under the new red sandstone, with which the surface is covered to the depth of at least twenty fathoms: the first workable seam of coal bored to at these two places is four feet six inches in thickness; at Ibstock it is about thirty-four, and at Whitwick about fifty fathoms beneath the surface.

Having ascertained the important fact, that the coal-measures, and probably the same coal-measures, extend under the sandstone from Whitwick to Ibstock, a distance of about three miles, and having satisfied myself by observations on the run of these coal strata in general, and of the strata near Whitwick, in particular, that they dip towards the transition strata until they come nearly in contact with them,—I was induced to consider it extremely probable that the coal-measures might still continue to follow the transition rocks, and to form a sort of belt or zone around them, traversing the country in the direction of Bagworth*, Desford, Kirby-Muxloe, and Glenfield, and crossing the Ashby road at the distance of about two miles from Leicester. I was led, therefore, to conclude that a trial for coal might be made with the greatest probability of success in any part of the dotted line C,D, in the grounds adjoining Sharman's Lodge. I had arrived at this conclusion, when met at Leicester by the person on whose account the survey was made, with whom it seemed to be a desideratum that a trial for coal should be made near Birstall (See the sketch). I preferred the other situation however, as being more eligible for such trial; because, owing to the distance of Birstall from the transition rocks, there appeared that every reason to suppose that the coal-measures would crop-out at or near that place; and consequently any trial for coal there, might probably be made beyond, or at all events too near their basset or outbreak, to afford any beneficial results. On being informed, however, that in cutting a road through a hill near Birstall, a thin bed of coal had been intersected, I immediately proceeded to examine the situation; in doing which, there was found, cer-

* It is near this village that coal has since been discovered.

tainly

tainly not the coal itself, but the outburst of a bed of such argillaceous schist as invariably accompanies coal-beds, mixed with a few small pieces of coal, probably proceeding from the outburst or crop of a seam within a very short distance of the spot. So strong indeed are the indications of coal at this place, that of its existence in the immediate vicinity I have not the slightest doubt. Of its qualities, thickness, &c., of course no idea can be formed without boring; but there is every reason to suppose that the same beds will be found here as those which are at present sinking to at Whitwick and Ibstock.

Note.—From the hasty manner in which this survey was made, I had no opportunity of taking elevations; but it is extremely probable that the outbreak of the coal-measures through the new red sandstone near Birstall is connected with the elevation of the ground. Near Ashby also I observed the like appearance under similar circumstances, where, although the low grounds are occupied by the deposit of new red sandstone, yet on the top of a hill a bed of siliceous sandstone, evidently belonging to the coal-measures, protrudes itself to the surface, and is quarried for the purposes of building.

F. F.

LII. *On the Measurement (by Trigonometry) of the Heights of the principal Hills of Wensleydale, Yorkshire.* By John Nixon, *Esq.**

EARLY in June last I commenced the above undertaking, and succeeded, notwithstanding the extremely unfavourable state of the weather, in completing the requisite measurements by the middle of July. With a view to increase the accuracy of the survey, the third or verification angles of some of the principal triangles were, however, obtained in September, at Ingleborough and Whernside; and in November, at Shunnor Fell: yet so unsatisfactory, in consequence of the continued haziness of the atmosphere, were the observations, as to render it doubtful whether it would not have been preferable to have rejected them.

In the selection of the hills, the transverse and lateral (or boundary) ridges, of which Wensleydale entirely consists, were surveyed; and the principal passes (or extreme depressions of the ridges) being ascertained, the loftiest point of ground comprehended between every two adjacent passes was carefully determined and marked for measurement. At the head of the dale, several of the transverse ridges, diverging with a gradual descent from one common crest, terminate in lofty and steep head-lands, or knabs. As no part of hills of this description could with propriety be designated the summit, the measurement of the height of any other point was not attempted.

* Communicated by the Author.

On commencing the survey, it was discovered that the twelve-inch telescopic-level, recently fitted up with extremely fine cross-wires, would not, from some imperfection in the screws of the stop, retain its adjustments. The extreme summit of the hill was, therefore, of necessity estimated by the eye alone previous to the erection of the signal. That no material error had been committed in the few doubtful cases which occurred, was subsequently confirmed; not only where the theodolite was erected, from actual levelling around the signal by means of that instrument, but also by remarking in the course of the observations that the horizontal wire of the telescope, when pointed at the base of the signal on any of the distant hills of about the same altitude as the station, did not dip sensibly below any other part of that hill. The signal on Bakestone Edge was found to be rather lower than a point more to the north; but the latter was evidently within the boundary of Swaledale, and consequently out of the limits of the survey. Viewed from the signal on the Stake Fell, a peat hillock nearly two miles to the south-east was suspected to be quite as high; but it was noted, on repairing there, that a straight line drawn from the hillock through the base of the signal, would touch a point of Water Crag very little below the level of its summit. Now as Water Crag has been determined to be about 350 feet higher than Stake Fell, it proves that the signal was placed considerably above the level of the hillock.

With regard to the structure of the signals, piles or pikes of stone were found on the loftiest points of Water Crag, Shunnor Fell, and Great Whernside, marking the precise site of signals of the Ordnance Survey. On Settronside, a well-built tower fifteen feet high and nine feet in diameter at the base, recently erected at a distance of forty-five yards to the north-east of the extreme summit of the fell, served as an excellent signal. On Lovely Seat there stands a lofty boundary pike situated some little below the level, but within a few yards of the highest point of the hill; to which point, in lieu of the base of the pike, on the measurement of the *vertical* angles the telescope was invariably directed. Stone towers about eight feet high, and nearly as much in diameter, marked the summits of High Fleak, Bakestone Edge, and Swarth Fell; the latter being erected on a large rock. The signals at Addlebrough and Rover Crag were of a similar description, but much inferior in dimensions. On the wall crossing the summit of Whitfield Hill were heaped, immediately over the most elevated point of ground, a number of loose stones; but this signal, from its insufficient dimensions, could seldom be distinctly seen through the telescope of the theodolite. The

other

other signals consisted of conical piles about twelve feet in diameter at the base, and seven or eight feet high, constructed externally of huge sods, and filled up with loose peat-earth. There exists, however, this great objection to a turf-signal placed on a peat moor,—that the observer may not be able to distinguish it, at a remote station, from the peat stacks with which it is liable to be surrounded. For instance, although the pile of sods marking the most elevated point of the extensive and nearly level summit of Penhill, famous for its excellent turbaries, was placed on the northern extremity of an elevated cam (or mound) dividing Walden from Coverdale; yet so numerous were the heaps of peat raised from time to time to the west and north, that the signal, when observed from stations in those directions, could seldom be satisfactorily identified;—an uncertainty which has led to unusual discrepancies in the measurements of such of the distances as relate to that signal.

The horizontal angles were, with one exception*, measured by the six-inch theodolite, minutely described in Phil. Mag. and Annals, vol. iii. pp. 83—86. At Bear's Head, Shunnor Fell, Bakestone Edge, and Penhill, immediately on completing one set of observations, the telescope was reversed in position within its Ys, and the observations, notwithstanding the consequent inconvenient position of the tangent screws, carefully repeated. From the unsettled state of the atmosphere, it would frequently occur that some of the distant hills had been obscured by mist or haze during the course of either the first or second set of observations, which rendered it necessary to apply to their readings the uncertain correction of half the mean difference of the two readings, registered for observations with the telescope in both positions. At Settronside, the summits of several of the fells were so rapidly shrouded in vapour that no time was afforded to reverse and re-adjust the telescope; but a few of the observations of most importance were repeated (by turning the screw situated under the parallel plates) on different parts of the divided circle.

It has been remarked, that the signals of the preceding survey, when observed from remote stations, although viewed under an angle considerably greater than that subtended by the fine vertical wire of the telescope, would totally disappear on interposing the latter; but the signals just described, from their superior magnitude, could be bisected in tolerably clear weather with the greatest ease and accuracy. On the occurrence, however, of haze in the atmosphere, the signal, suffi-

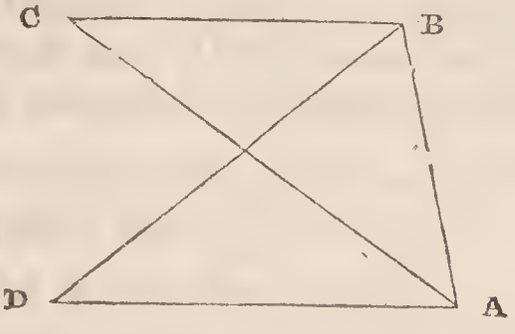
* The angle at Rover Crag between Harlen Fell and Penhill.

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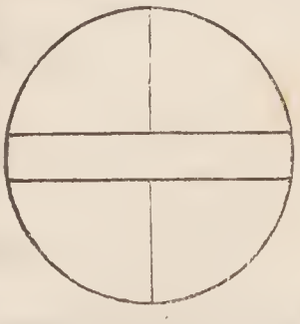
ciently visible on entering the field of view of the telescope, became gradually more indistinct as it approached the wire, and wholly faded out of view at a distance from it of one or two minutes*.

Another annoying impediment to accurate bisection, the consequence of some defect in the tangent screw, or clamp, of the horizontal circles, requires to be noticed. Occasionally, on turning the screw in the proper direction to rectify an approximate bisection, the vertical wire of the telescope, after refusing for some time to obey its action, would be displaced in azimuth, not gradually, but at once, the quantity due to the degree of revolution of the screw.

In the registers of the measurement of the horizontal angles, there is given for every signal observed the mean of the various corresponding readings, reduced, when requisite, to the centre of the signal. At several of the stations some few of the more distant signals were never sufficiently clear for bisection; but the consequent blanks in the registers, marked M, or C, have been supplied, the former from the accurate data of Colonel Mudge, and the latter, by the following method, from the registers of the other stations. At A the signals C and D were observed, but B could not be seen. From the registers of C and B the angles CBA and BCA are extracted, and the angle CAB obtained by subtracting their sum from 180°. Adding this angle to the reading for the signal C, as given in the register of the observations made at A, (the graduations of the theodolite being numbered from left to right,) their sum is sub-



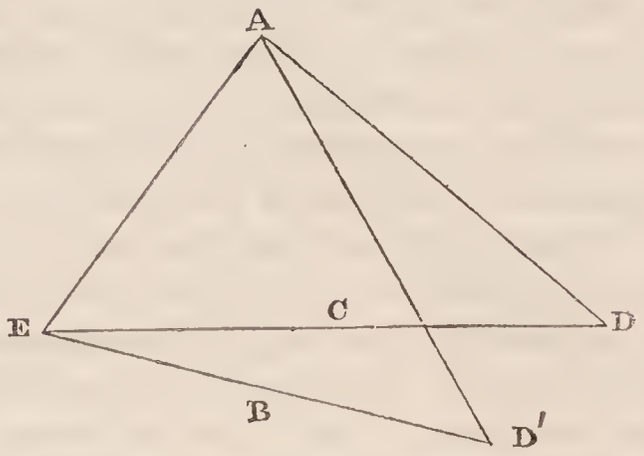
* I have lately had a telescope fitted up with two horizontal *thick* wires, to each of which is attached a delicate filament, both placed, as exhibited in the figure, in the same vertical line. In making an observation the telescope is moved until the signal appears to be equidistant from the horizontal wires, and as exactly bisected by an imaginary line connecting the two vertical filaments as the eye can estimate. In measuring vertical angles the telescope is to be half inverted within its Ys, and the filaments rendered truly horizontal.



Captain Kater and his associates experienced in hazy weather the same difficulty, or rather impossibility, of bisecting distant signals by the intersection of the (three) wires of their powerful telescope, but succeeded on making use of a minute particle of dust, fixed by Mr. Gardner, on the horizontal wire. (Phil. Trans. 1828, p. 194). This method, it is to be doubted, would scarcely answer if applied to an ordinary telescope.

stituted in the register for an actual observation of the signal B. When A and B had been seen also from D (or any other station), two or more values of the required reading were procured by the same process of calculation, of which the mean was adopted.

When the distance between two signals (E, A) has been measured from several bases (C, B, &c.), the claim to accuracy of each measurement has been considered, in the determination of the proper mean, to be *inversely* as the greatest error to which, limiting the uncertainty of observation to one minute, it may be deemed liable. This *maximum* error of the distance in *logarithms* (x) was calculated by the following formulæ, in which d denotes the difference between the log. sine of the angle D, and that of the same angle $\pm 1'$, and a the corresponding difference for the angles A and A $\pm 1'$.



Class I.—Given the observed angles E, A, D, each corrected by one-third of the difference of their sum and 180°.

Case 1.—D and A being acuté.

$x = d + a$, when $a = d$;

$x = \frac{2d + 4a}{3}$, when a exceeds d;

$x = \frac{4d + 2a}{3}$, when d exceeds a.

Case 2.—When either D or A is obtuse.

$x = \frac{2d + 2a}{3}$, when $a = 2d$, or $d = 2a$;

$x = \frac{4d - 2a}{3}$, when d exceeds $2a$;

$x = \frac{4a - 2d}{3}$, when a exceeds $2d$.

Class II.—Given the observed angles D and A only.

$x = a + d$; D and A being both acute, or either of them obtuse.

Class III.—Given the observed angles E and A only.

Case

Case 1.—D and A being acute.

$x = a + 2d.$

Case 2.—When either D or A is obtuse.

$x = 2d - a$, when d exceeds a;
$x = a$, when a exceeds d.

Class IV.—Given the observed angles D and E only.

Case 1.—D and A being acute.

$x = 2a + d.$

Case 2.—When either D or A is obtuse.

$x = 2a - d$, when a exceeds d;
$x = d$, when d exceeds a.

It is almost superfluous to remark, that the logarithmic differences are treated in the notation as common numbers.

The following list contains for every triangle of which all the angles have been observed, the difference of their sum and 180°.

−0′ 1″	−0′ 28″	−0′ 41″	−1′ 4″	−2′ 6″	+0′ 42″
0 4	0 29	0 42	1 6	+0 14	0 44
0 13	0 30	0 42	1 10	0 21	0 58
0 14	0 30	0 47	1 25	0 21	1 29
0 17	0 35	0 55	1 27	0 31	1 29
0 27	0 39	1 2	1 28	0 31	

Mean error 45″, or 15″ per angle.

Registers of the Measurement of the Horizontal Angles.

At Shunnor Fell.

	Readings.
Water Crag	0° 0′ 0″
Pickington Ridge	52 30 20
Bakestone Edge	61 5 42
Penhill	73 12 20
Lovely Seat	78 56 20
Gt Whernside (M)	99 4 20
Settronside	101 2 56
Bear's Head	119 1 37
Ten End	133 31 30
Pen-y-gent (C)	134 45 16
Dod Fell	135 43 47
Ingleborough	157 39 3
Knoutberry Hill	162 58 15
Whernside	167 5 18
The Sayls	212 22 18
Swarth Fell	218 25 10
Wildboar Fell	231° 59′ 12″
Pillar Hill	247 6 5

At Ingleborough.

	Readings.
Whernside	36° 23′ 6″
Shunnor Fell	63 59 40
Water Crag (M)	70 42 4
Dod Fell	83 58 52
Bear's Head	86 9 3
Settronside	117 48 14
Gt Whernside (M)	130 10 28
Pen-y-gent	135 43 10

At Whernside.

Ten End	4° 27′ 23″
Bear's Head	10 44 18
Dod Fell	15 39 17

	Readings.
Settronside	38° 51′ 16″
Gt Whernside (M)	48 5 8
Pen-y-gent	70 56 56
Ingleborough	119 52 33
Wildboar Fell	308 31 0
Shunnor Fell	336 55 52
Water Crag (M)	341 34 35
Knoutberry Hill	343 17 51
Whaw Fell	358 40 48

At Settronside.

Shunnor Fell	8° 23′ 48″
Lovely Seat	12 52 13
Stake Fell	20 6 13
Bakestone Edge	26 49 22
Water Crag	32 39 7
Pickington Ridge	51 41 21
Wasset Fell	68 35 5
Whitfield Hill	78 10 38
Penhill	86 27 49
Rover Crag	113 13 44
Great Haw	127 15 56
Little Whernside	139 36 42
Great Whernside	179 44 17
Pen-y-gent (C)	285 48 6
Ingleborough	298 49 36
Whernside	316 23 40
Yockenthwaite Moor	333 35 33
Dod Fell	334 55 20
Swarth Fell	350 38 10
Bear's Head	351 52 10
The Sayls	359 2 7

At Bakestone Edge.

Water Crag	19° 42′ 10″
Pickington Ridge	107 26 18
High Fleak	113 45 40
Penhill Beacon	138 36 35
Penhill	144 44 43
Little Whernside	165 52 15
Great Whernside	176 41 57
Addlebrough	179 6 37
Settronside	184 14 49
Stake Fell	188 6 40

	Readings.
Yockenthwaite Moor	203° 34′ 15″
Bear's Head	229 40 58
Dod Fell	236 18 48
Ten End	242 50 4
Lovely Seat	291 16 2
Shunnor Fell	305 53 30

At Bear's Head.

Lovely Seat	8° 12′ 20″
Water Crag	21 45 58
Bakestone Edge	37 6 18
High Fleak	51 49 47
Pickington Ridge	61 15 48
Whitfield Hill	74 17 9
Addlebrough	83 33 48
Penhill	97 3 16
Harlen Fell	103 27 16
Stake Fell	113 9 3
Great Haw	114 54 19
Wasset Fell	119 45 11
Brownhaw	123 6 48
Little Whernside	125 0 4
Settronside	136 43 18
Yockenthwaite Moor	152 11 27
Pen-y-gent (C)	199 17 15
Ingleborough	232 1 32
Dod Fell	239 44 46
Whernside	253 6 25
Whaw Fell	261 51 49
Knoutberry Hill	277 30 25
Ten End	282 15 51
Swarth Fell	314 31 17
Wildboar Fell	320 49 35
The Sayls	331 0 26
Pillar Hill	337 2 44
Shunnor Fell	351 13 16

At Pen-y-gent.

Ingleborough	54° 6′ 15″
Whernside	85 50 7
Dod Fell	138 21 49
Shunnor Fell	139 28 19
Bear's Head	151 48 5

Yock-

	Readings.		
Yockenthwaite Moor	179°	33′	29″
Penhill	194	39	53
Settronside	203	9	35
Great Whernside	225	14	0

At Penhill.

Brownhaw	4°	46′	3″
Settronside	17	43	6
Wasset Fell	26	2	37
Yockenthwaite Moor	40	1	34
Stake Fell	51	51	37
Bear's Head	63	28	23
Addlebrough	74	0	9
Lovely Seat (misty)	90	36	3
Shunnor Fell (misty)	91	47	4*
Bakestone Edge	98	34	29
High Fleak	106	38	10
Pickington Ridge	124	38	50
Caldberg Moor	255	54	18
Rover Crag (C)	279	56	48
Great Haw (C)	302	26	57
Little Whernside	337	16	10
Great Whernside	347	17	39
Harlen Fell	359	10	25

At Dod Fell.

Settronside	0°	35′	32″
Great Whernside	8	36	39
Pen-y-gent	66	41	17
Ingleborough	110	40	58

	Readings.		
Whernside	138°	51′	24″
Knoutberry Hill	182	41	42
Shunnor Fell	248	46	2
Penhill	330	52	7

At Little Whernside.

Settronside		157°	49′	5″
Bear's Head		178	21	2
Bakestone Edge	(C)	206	38	28
Penhill		244	11	48
Penhill Beacon		254	3	8
Whitfield Hill		256	45	35
Rover Crag		286	27	3
Great Haw		307	59	30

At Rover Crag†.

Little Whernside	105°	45′	15″
Settronside	130	43	15
Harlen Fell	166	41	55
Penhill	186	10	45
Whitfield Hill	239	4	0
East Witton Fell	294	1	15

At the Great Haw†.

Little Whernside	44°	19′	41″
Settronside	61	47	15
Brownhaw	69	28	30
Wasset Fell	78	59	0
Bear's Head	84	35	0
Penhill	125	42	45
Penhill Beacon	139	39	7

Calculation of the mean Distances.

	Bases from the Ordnance Survey.	Feet.
I.	Shunnor Fell to Whernside	63377
II.	——— Ingleborough	82397
III.	——— Water Crag	35705
IV.	——— Great Whernside	91758
V.	Ingleborough to Whernside	22435
VI.	——— Water Crag	116216
VII.	——— Great Whernside	85598
VIII.	Whernside to Water Crag	98502
IX.	——— Great Whernside	89915

* Rejected in the calculation of the distance from Shunnor Fell to Penhill.

† At Rover Crag and Great Haw the theodolite was placed exactly over the centre of the signal.

Shunnor

Shunnor Fell to Settronside.

	Feet.
By Shunnor Fell and Whernside	70957
——— Ingleborough	70965
——— Water Crag	70931
Mean	70953

Water Crag to Settronside.

By Water Crag and Shunnor Fell	85304
——— Ingleborough	85327
——— Whernside	85313
Mean	85315

Whernside to Settronside.

By Whernside and Shunnor Fell	73489
——— Ingleborough	73506
——— Water Crag	73513
——— G^{t} Whernside	73467
Mean	73491

Ingleborough to Settronside.

By Ingleborough and Shunnor Fell	73410
——— Whernside	73428
——— Water Crag	73414
——— G^{t} Whernside	73409
Mean	73411

Shunnor Fell to Bear's Head.

By Shunnor Fell and Ingleborough	35613
——— Whernside	35625
——— Water Crag	35581
——— Settronside	35632
Mean	35617

Water Crag to Bear's Head.

By Water Crag and Ingleborough	61502
——— Whernside	61467
——— Shunnor Fell	61430
——— Settronside	61466
Mean	61460

Whernside to Bear's Head.

By Whernside and Ingleborough	47609
——— Shunnor Fell	47626
——— Water Crag	47619
——— Settronside	47621
Mean	47619

Ingleborough to Bear's Head.

By Ingleborough and Whernside	58910
——— Shunnor Fell	58933
——— Water Crag	58950
——— Settronside	58914
Mean	58923

Settronside to Bear's Head.

	Feet.
By Settronside and Ingleborough	38690
——— Whernside	38672
——— Water Crag	38667
——— Shunnor Fell	38659
Mean	38676

Shunnor Fell to Bakeston Edge.

By Shunnor Fell and Water Crag	26333
——— G^{t} Whernside	26291
——— Settronside	26330
——— Bear's Head	26327
Mean	26326

Water Crag to Bakestone Edge.

By Water Crag and Shunnor Fell	32548
——— Bear's Head	32536
Mean	32543

Great Whernside to Bakestone Edge.

By G^{t} Whernside and Shunnor Fell	72853

Settronside to Bakestone Edge.

By Settronside and Shunnor Fell	53508
——— Bear's Head	53524
Mean	53517

Bear's Head to Bakestone Edge.

By Bear's Head and Shunnor Fell	31077
——— Water Crag	31090
——— Settronside	31100
Mean	31084

Shunnor Fell to Pen-y-gent.

By Shunnor Fell and Ingleborough	78500
——— Whernside	78505
——— G^{t} Whernside	78499
Mean	78502

Ingleborough to Pen-y-gent.

By Ingleborough and Shunnor Fell	32168
——— Whernside	32157
——— Bear's Head	32154
Mean	32160

Whernside to Pen-y-gent.

By Whernside and Shunnor Fell	42097
——— G^{t} Whernside	42094
——— Ingleborough	42090
——— Bear's Head	42085
Mean	42092

Great

Great Whernside to Pen-y-gent.

	Feet.
By Gt Whernside and Shunnor Fell	53668
——— Whernside	53680
Mean	53676

Bear's Head to Pen-y-gent.

By Bear's Head and Ingleborough	45258
——— Whernside	45250
Mean	45254

Settronside to Pen-y-gent.

By Pen-y-gent and Gt Whernside	43933
——— Shunnor Fell	43933
——— Bear's Head	43944
——— Whernside	43944
Mean	43938

Great Whernside to Settronside.

By Gt Whernside and Whernside	21015
——— Ingleborough	20985
——— Pen-y-gent	20991
Mean	20993

Shunnor Fell to Dod Fell.

By Shunnor Fell and Gt Whernside	42182
——— Whernside	42167
——— Ingleborough	42166
——— Settronside	42166
——— Bear's Head	42163
Mean	42168

Ingleborough to Dod Fell.

By Ingleborough and Shunnor Fell	46055
——— Settronside	46048
——— Pen-y-gent	46068
——— Whernside	46068
Mean	46060

Whernside to Dod Fell.

By Whernside and Shunnor Fell	35083
——— Settronside	35087
——— Ingleborough	35095
——— Pen-y-gent	35096
Mean	35090

Pen-y-gent to Dod Fell.

By Pen-y-gent and Gt Whernside	36326
——— Settronside	36337
——— Ingleborough	36354
——— Whernside	36356
Mean	36343

Bear's Head to Dod Fell.

	Feet.
By Bear's Head and Settronside	13014
——— Shunnor Fell	13022
Mean	13018

Settronside to Dod Fell.

By Settronside and Ingleborough	43506
——— Whernside	43497
——— Shunnor Fell	43499
——— Bakestone Edge	43496
——— Pen-y-gent	43485
——— Bear's Head	43498
Mean	43497

Bakestone Edge to Dod Fell.

By Bakestone Edge and Settronside	43398

Great Whernside to Dod Fell.

By Gt Whernside and Shunnor Fell	63159
——— Pen-y-gent	63148
Mean	63154

Shunnor Fell to Penhill.

By Shunnor Fell and Pen-y-gent	72176
——— Bear's Head	72171
——— Settronside	72185
——— Dod Fell	72148
Mean	72170

Bear's Head to Penhill.

By Bear's Head and Shunnor Fell	53800
——— Settronside	53821
——— Bakestone Ed.	53841
——— Pen-y-gent	53800
Mean	53816

Bakestone Edge to Penhill.

By Bakestone Edge and Settronsi.	46773
——— Gt Whernside	46797
——— Bear's Head	46788
Mean	46786

Pen-y-gent to Penhill.

By Pen-y-gent and Shunnor Fell	77287
——— Dod Fell	77320
——— Bear's Head	77292
Mean	77300

Dod Fell to Penhill.

By Dod Fell and Shunnor Fell	64623
——— Settronside	64660
——— Pen-y-gent	64660
Mean	64648

Great

Great Whernside to Penhill. Feet.

By Gt Whernside and Settronside	41388
——— Bakestone Edge	41378
Mean	41383

Settronside to Penhill.

By Settronside and Shunnor Fell	34459
——— Bear's Head	34462
——— BakestoneEd.	34481
——— Gt Whernside	34490
——— Dod Fell	34467
Mean	34472

Bear's Head to Little Whernside.

By Bear's Head and BakestoneEdge	58851
——— Penhill	58850
——— Settronside	58847
Mean	58849

Penhill to Little Whernside.

By Penhill and Bear's Head	27642
——— Settronside	27642
——— Bakestone Edge	27656
Mean	27647

Bakestone Edge to Little Whernside.

By Bakestone Edge & Bear's Head	65539
——— Settronside	65540
——— Penhill	65562
Mean	65547

Settronside to Little Whernside.

By Settronside and Bear's Head	22402
——— BakestoneEd.	22412
——— Penhill	22413
Mean	22409

Bear's Head to Great Haw.

By Bear's Head and Settronside	70107
——— Penhill	70117
Mean	70112

Penhill to Great Haw.

By Penhill and Bear's Head	25080
——— Settronside	25078
Mean	25079

Settronside to Great Haw.

By Settronside and Bear's Head	37098
——— Penhill	37117
Mean	37115

Great Haw to Little Whernside. Feet.

By Little Whernside and Penhill	15966
— Penhill to Great Haw	15961
Mean	15964

Penhill to Rover Crag.

By Penhill and Settronside	18846
——— Little Whernside	18853
Mean	18850

Settronside to Rover Crag.

By Settronside and Penhill	41465
——— Lit. Whernside	41460
Mean	41463

Little Whernside to Rover Crag.

By Lit. Whernside and Penhill	23600
——— Settronside	23591
Mean	23596

Rover Crag to Caldberg Moor.

By Rover Crag and Penhill	10315

Penhill to Caldberg Moor.

By Rover Crag and Penhill	24101

Settronside to Caldberg Moor.

By Rover Crag and Penhill	51430

Penhill to Harlen Fell.

By Penhill and Rover Crag	6360
——— Bear's Head	6356
Mean	6358

Bear's Head to Harlen.

By Bear's Head and Penhill	51380

Rover Crag to Harlen.

By Rover Crag and Penhill	18734

Bear's Head to Wasset Fell.

By Bear's Head and Settronside	37719
——— Penhill	37720
Mean	37720

Penhill to Wasset Fell.

By Penhill and Bear's Head	23948
——— Great Haw	23952
Mean	23950

Settronside to Wasset Fell.

By Settronside and Great Haw	11315
——— Bear's Head	11312
Mean	11314

Bear's

Bear's Head to Brownhaw.

	Feet.
By Bear's Head and Penhill	46179
——————— Great Haw	46169
Mean	46174

Penhill to Brownhaw.

By Penhill and Bear's Head	23740
——————— Great Haw	23737
Mean	23738

Little Whernside to Penhill Beacon.

By Little Whernside & Bakestone Edge	31131
——————— Great Haw	31100
Mean	31115

Bakestone Edge to Penhill Beacon.

By Bakestone Edge and Little Whernside	50038

Great Whernside to Penhill Beacon.

By calculation	46592

Bear's Head to Whitfield Hill.

By Bear's Head and Settronside	74385
——————— Lit. Whernside	74311
Mean	74337

Settronside to Whitfield Hill.

By Settronside and Bear's Head	66079
——————— Rover Crag	66004
Mean	66034

Shunnor Fell to Pickington Ridge.

By Shunnor Fell and Settronside	48679
——————— Bear's Head	48692
——————— Penhill	48678
Mean	48683

Bakestone Edge to Pickington Ridge.

By Bakestone Edge and Settronside	22980
——————— Bear's Head	22990
——————— Penhill	23001
Mean	22990

Bear's Head to Pickington Ridge.

By Bear's Head and Settronside	47513
——————— Shunnor Fell	47514
——————— Bakestone Ed.	47512
——————— Penhill	47498
Mean	47509

Penhill to Pickington Ridge.

	Feet.
By Penhill and Settronside	31725
——————— Shunnor Fell	31709
——————— Bear's Head	31707
——————— Bakestone Edge	31719
Mean	31715

Settronside to Yockenthwaite Moor.

By Settronside and Pen-y-gent	18562
——————— Bear's Head	18570
——————— Bakestone Edge	18563
——————— Penhill	18563
Mean	18564

Bear's Head to Yockenthwaite Moor.

By Bear's Head and Settronside	21834
——————— Pen-y-gent	21834
——————— Bakestone Ed.	21832
——————— Penhill	21846
Mean	21836

Bakestone Edge to Yockenthwaite Moor.

By Bakestone Edge and Settronside	44937
——————— Bear's Head	44926
——————— Penhill	44945
Mean	44936

Penhill to Yockenthwaite Moor.

By Penhill and Settronside	45059
——————— Bear's Head	45048
——————— Bakestone Edge	45078
Mean	45062

Settronside to Stake Fell.

By Settronside and Bear's Head	19679
——————— Penhill	19677
Mean	19678

Bear's Head to Stake Fell.

By Bear's Head and Settronside	23281
——————— Bakestone Ed.	23279
Mean	23280

Penhill to Stake Fell.

By Penhill and Settronside	32117
——————— Bakestone Edge	32126
Mean	32122

Bakestone Edge to Stake Fell.

By Bakestone Edge & Bear's Head	34046
——————— Penhill	34058
Mean	34052

Bear's Head to Addlebrough. Feet.

By Bear's Head & BakestoneEdge 24192
——————— Penhill 24159
Mean 24175

Penhill to Addlebrough.

By Penhill and Bakestone Edge 30836
——————— Bear's Head 30843
Mean 30840

Bakestone Edge to Ten End.

By BakestoneEdge & ShunnorFell 35800
——————— Bear's Head 35793
Mean 35797

Bear's Head to Ten End.

By Bear's Head and Shunnor Fell 8975
——————— BakestoneEdge 8974
Mean 8975

Shunnor Fell to Pillar Hill.

By Shunnor Fell and Bear's Head 14247

Bear's Head to Pillar Hill.

By Shunnor Fell and Bear's Head 45798

Shunnor Fell to the Sayls.

By Shunnor Fell and Bear's Head 13426
——————— Settronside 13420
Mean 13423

Bear's Head to the Sayls.

By Bear's Head and Shunnor Fell 38790

Shunnor Fell to Wildboar Fell.

By Shunnor Fell and Whernside 30208
——————— Bear's Head 30192
Mean 30200

Bear's Head to Wildboar Fell.

By Bear's Head and Whernside 54951
——————— Shunnor Fell 54946
Mean 54948

Shunnor Fell to Swarth Fell.

By Shunnor Fell and Bear's Head 30693
——————— Settronside 30679
Mean 30686

Bear's Head to Swarth Fell.

By Shunnor Fell and Bear's Head 50670

Great Whernside to Swarth Fell.

By calculation 110096

Bear's Head to Knoutberry Hill. Feet.

By Bear's Head and Shunnor Fell 27905*

Shunnor Fell to Knoutberry Hill.

By Bear's Head and Shunnor Fell 38598*

Great Whernside to Knoutberry Hill.

By calculation 82426

Bear's Head to Whaw Fell.

By Bear's Head and Whernside 27993*

Shunnor Fell to Lovely Seat.

By Shunnor Fell and Bear's Head 12396
——————— BakestoneEd. 12382
Mean 12390

Bakestone Edge to Lovely Seat.

By Bakestone Edge and Shunnor Fell .... } 15027
——————— Bear's Head 15023
——————— Settronside 15050
Mean 15033

Penhill to Lovely Seat.

By Penhill and Settronside 59875
——————— Bear's Head 59852
Mean 59863

Settronside to Lovely Seat.

By Settronside and Penhill 59652
——————— Bakestone Edge 59683
Mean 59667

Bear's Head to Lovely Seat.

By Bear's Head and Shunnor Fell 27326
——————— Bakestone Edge 27340
——————— Penhill 27296
Mean 27321

Penhill to High Fleak.

By Penhill and Bear's Head 38218
——————— Bakestone Edge 38235
Mean 38226

Bear's Head to High Fleak.

By Bear's Head & Bakestone Edge 36846
——————— Penhill 36829
Mean 36838

Bakestone Edge to High Fleak.

By BakestoneEdge & Bear's Head 10413
——————— Penhill 10415
Mean 10414

[To be continued.]

* See Phil. Mag. and Annals, vol. iii. pages 94, 95.

LIII. *On*

LIII. *An Abstract of the Characters of* Ochsenheimer's *Genera of the Lepidoptera of Europe; with a List of the Species of each Genus, and Reference to one or more of their respective Icones. By* J. G. Children, *F.R.S. L. & E. F.L.S. &c.*

[Continued from p. 296.]

Genus 47. CYMATOPHORA, *Ochs., Treitsch.*

Tethea, Ochs. Bombyciæ, Hübn.

Wings deflexed.
Body sub-pilose.
Antennæ filiform in both sexes; in the male cylindrical, and very large; in the female flattened.—*Godart, Dup.**

Fam. A. Anterior wings with the posterior margin incurved, and the posterior angle acute, pointed.

Species.	Icon.
1. Cym. *Ambusta*, Fab....	Ernst, VII. Pl. CCXCV. f. 500. a. c. (b. var.)
2. — *Retusa*, Linn.....	Ernst, VII. Pl. CCLIX. f. 402. d.
3. — *Subtusa*, Fab.....	Ernst, VII. Pl. CCLIX. f. 402. a—c.

Fam. B. *a*. Anterior wings elongate, with cancellated markings.

4. Cym. *Oo*, Linn.	Hübn. Noct. Tab. 41. f. 195. (fœm.)
5. — *Xanthoceros*, Hübn.	Ernst, VI. Pl. CCXIV. f. 291.

Fam. B. *b*. Wings broad, elongate, variegated, with wavy markings.

6. Cym. *Ruficollis*, Fab...	Ernst, VI. Pl. CCXLII. f. 358.
7. — *Diluta*, Fab.	Ernst, IV. Pl. CLXI. f. 208.
8. — *Bipuncta*, Borkh.	Ernst, VIII. Pl. CCCIX. f. 535.
9. — *Fluctuosa*, Hübn.	Ernst, VIII. Pl. CCCIX. f. 534.
10. — *Octogesima*, Hübn.	Ernst, VIII. Pl. CCCVIII. f. 532.
11. — *Or*, Fab.	Ernst, VIII. Pl. CCCVIII. f. 533.
12. — *Flavicornis*, Linn.	Ernst, VI. Pl. CCXLIII. f. 359.

* We have added this character, derived from the Antennæ, from Dupouchel's continuation of Godart's *Lépidoptères de France;* as it seems to prevail in all the species quoted by Treitschke, as composing this genus. Miserably deficient as Ochsenheimer's generic characters generally are, those of his successor, thus far at least, are still more so. Indeed his genera can only be satisfactorily determined by examining the principal species included, respectively, in them,—a labour we have neither leisure nor inclination to undergo. We shall therefore give Treitschke's characters as we find them, with such additions from other quarters as we can safely rely on, referring our readers to the Species themselves, or their Icones, for further means of distinguishing the several groups.

Fam. B. *c.* Anterior wings broad, short, with faint, wavy markings.

Species.	Icon.
13. Cym. *Saliceti*, Hübn.	Ernst, VI. Pl. CCXL. f. 352. —*a.* Larva.—*b.* Pupa.
14. — *Congener*, Hübn.	Hübn. Noct. Tab. 135. f. 617. (fœm.)
15. — *Scoriacea*, Esper.	Ernst, VII. Pl. CCLXXXIV. f. 469.

Genus 48. EPISEMA, *Ochs.* (*Steph.*)

Graphiphoræ, Hübn. Heteromorphæ, Hübn.

Legs very hairy; *tibiæ* with spurs.

Wings elongate; *anterior* with the hinder margin entire, deflexed; *cilia* long.

Antennæ rather elongate, not curved, bipectinated to the apex in the males, simple in the females: *head* exserted, not very small: *thorax* slightly crested with transverse fasciæ: *abdomen* rather stout, with a simple tuft at the apex.

Palpi elongate, very pilose, biarticulate, the basal joint large, the terminal very slender, elongate, acute, scaly: *maxillæ* short.

Larva cylindric, very fleshy and robust, not tuberculate; the *hinder legs* perfect.

Pupa folliculated*.

Species.	Icon.
1. Ep. *Cæruleocephala*, Linn.	Ernst, V. Pl. CLXXXVI. f. 242.
2. — *I. cinctum*, Hübn.	Hübn. Noct. Tab. 30. f. 144. (mas.)
3. — *Trimacula*, Hübn.	Hübn. Noct. Tab. 30. f. 141. (mas.) 142. (fœm.)
4. — *Tersa*, Hübn.....	Hübn. Noct. Tab. 30. f. 140. (fœm.)
5. — *Graminis*, Linn.†	Ernst, VI. Pl. CCLVII. f. 395.

Genus

* Characters chiefly from Stephens.

† Charæas, Steph.

"*Palpi* very short, triarticulate, the two basal joints densely squamous, the terminal slightly exposed, the basal joint shorter and stouter than the following, which is stout at the base and gradually attenuated to the apex, the terminal slightly elongate, acute, or ovate acuminate: *maxillæ* long. *Antennæ* simple in the females, more or less pectinated in the males: *head* small, squamous: *thorax* robust, not crested: *body* short, slightly carinated on the back; the apex of the males with a tuft: *wings* generally denticulated on the hinder margin, sometimes rounded; *posterior* not very large, ovate-triangular, usually whitish in the males, fuscous in the females. *Larva* naked, radicivorous: *pupa* subterraneous."—*Steph. Illust. Brit. Ent. Haust.* II. 108.

The British species which Stephens inserts in this genus, are: *Noct. cespitis,*

Genus 49. AGROTIS, *Ochs.* (*Curtis, Steph.*)

AGROTES, Hübn. — GRAPHIPHORÆ, Hübn. (Steph.)
(NOCTUA, Linn. — PHALÆNA, Don.)

Legs, *anterior* the shortest: *tibiæ*, *anterior* very short, with a flat spine on the inner side: *tarsi* with five joints.

Wings horizontal and crossing each other when at rest; the *upper* generally narrowed towards the base.

Antennæ long, setaceous, strongly pectinated in the males, especially towards the base; merely covered with bristles at the apex; simple and pubescent in the females.

Head small, thickly clothed with scales: *thorax* densely squamous, not crested.

Maxillæ as long as the antennæ, robust, furnished with tentacula at the apex.

Palpi, *labial* nearly vertical, divaricating, very robust, thickly clothed with long scales.

Larva with six *pectoral*, eight *abdominal*, and two *anal* feet; subterranean, naked, radicivorous.

Pupa subterranean. *

Curtis subdivides this genus into two groups:

A. Antennæ pectinated in the males.

a. nearly to the apex.

This subdivision contains the following species:

Ag. nigra, Haw. — *fusca*, Haw. — *cinerea*, Hübn., Curtis.

b. pectinated only half their length: in this are contained, *Ag. suffusa*, Hübn. — *æqua*, Hübn. — *subterranea*, Haw. — *monostigma*, Curtis. — *segetum*, Hübn. — *affinis*, — *elavigera*, Haw. — *pupillata*, Haw. — *sagittifera*, Hübn. — *hibernica*, Haw. MSS. — *pascua*, Curtis.

B. Antennæ of the males producing fascicles of hair only.

Ag. cespitis, Hübn. — *autumnalis*, Curt. — *exclamationis*, Linn. — *picea*, Haw. — *corticea*, Hübn. — *ruris*, Hübn. — *nigricans*, Linn. — *valligera*, Fab. — *obelisca*, Hübn.? — *albilinea*, Haw. — *lineolata*, Haw. — *radius*, Haw. — *radiolus*, Haw. MSS. — *subgothica*, Haw.

cespitis, Wien. Verz.—*Ch. confinis*, Steph.—*Bo. fuscus*, Haworth.—*Noct. nigra*, Haw.—*Ph. Bo. Graminis*, Linn.—Stephens observes, that the typical species of this genus are distinguished by having their wings more or less denticulated, but in *Ch. Graminis* (which ought probably to be separated from the rest as a distinct genus) they are entire.

* Characters from Curtis and Stephens.

Species.	Icon.
1. Ag. *Rectangula*, Fab.	Hübn. Noct. Tab. 24. f. 110. (fœm.)
2. — *Multangula*, Hübn.	Hübn. Noct. Tab. 25. f. 116. (mas.)
3. — *Ocellina*, Hübn.	Ernst, VII. Pl. CCLXVI. f. 420.
4. — *Lidia*, Hübn.	Hübn. Noct. Tab. 149. f. 649. (fœm.) 650. (mas.)
5. — *Vitta*, Hübn.....	Hübn. Noct. Tab. 115. f. 533. (mas.) 534. (fœm.)
6. — *Aquilina*, Hübn...	Hübn. Noct. Tab. 29. f. 135. (mas.) Tab. 115. f. 535. (mas.)
7. — *Tritici*, Linn.....	Hübn. Noct. Tab. 101. f. 479. (mas.) Tab. 136. f. 623. (fœm.)
8. — *Fumosa*, Fab.....	Ernst, VI. Pl. CCLVI. f. 391.
9. — *Obelisca*, Hübn...	Ernst, VII. Pl. CCLXXV. f. 443.
10. — *Buris*, Hübn.....	Ernst, VII. Pl. CCLXXVI. f. 446. b.
11. — *Saucia*, Hübn. ...	Ernst, VII. Pl. CCLXXVIII. f. 453.
12. — *Æqua*, Hübn.	Hübn. Noct. Tab. 122. f. 564. (mas.)
13. — *Suffusa*, Fab.....	Ernst, VII. Pl. CCLXXVII. f. 452.
14. — *Annexa*,*	— — —
15. — *Segetum*, Hübn....	Ernst, VII. Pl. CCLXXVII. f. 448. a.
16. — *Corticea*, Hübn...	Hübn. Noct. Tab. 31. f. 145. (mas.)
17. — *Exclamationis*, Linn.	Ernst, VII. Pl. CCLXXV. f. 442.
18. — *Valligera*, Fab....	Ernst, VII. Pl. CCLXXIV. f. 441.
19. — *Crassa*, Hübn.†...	Ernst, VII. Pl. CCLXXVI. f. 446. a.
20. — *Forcipula*, Hübn.	Hübn. Noct. Tab. 27. f. 128. (fœm.) Tab. 118. f. 547. (mas.)
21. — *Signifera*, Hübn.	Ernst, VI. Pl. CCLIII. f. 381.

* Agr. alis anticis fuscis, vittâ marginis superioris apiceque pallidioribus, lineolâ maculas duas jungente ordinarias atrâ.

† Graphiphora, Steph.

" *Palpi* moderate, ascending, parallel, densely clothed with scales, the base pilose, the terminal joint distinct, squamous; triarticulate, the basal joint curved, the second longer than the first, slightly attenuated, the terminal small, elongate-ovate, a little acuminated: *maxillæ* as long as the antennæ. *Antennæ* various, moderate, generally simple, with the lower surface pubescent in the females; usually ciliated beneath in the males, or deeply bipectinated, with the pectinations abbreviated towards the apex, sometimes serrated and pubescent beneath: *head* large, scaly: *thorax* slightly crested: *wings* generally rather broad, slightly rounded behind, horizontal during repose, not denticulated; mostly griseous or dusky, with dark spots towards the costa. *Larva* exposed, usually with pale lateral stripes, naked: *pupa* subterranean." —*Steph. Illust. Brit. Ent. Haust.* II. p. 128.

22. Ag. *Sa-*

Species.	Icon.
22. Ag. *Sagittifera*, Hübn.	Hübn. Noct. Tab. 114. f. 532.
23. — *Ripæ*, Hübn.	Hübn. Noct. Tab. 151. f. 702. 703. (mas.)
24. — *Cursoria*, Hübn.	Hübn. Noct. Tab. 116. f. 540. (mas.)
25. — *Cinerea*, Hübn. ...	Curtis, Brit. Ent. IV. pl. 165. Hübn. Noct. Tab. 33. f. 155. (mas.) f. 156. (fœm.)
26. — *Tenebrosa*, Hübn.*	Ernst, VI. Pl. CCLV. f. 387.
27. — *Pancratii*, Hübn.	Hübn. Noct. Tab. 84. f. 391. (fœm.)
28. — *Æthiops*, Hübn.†	Ernst, VII. Pl. CCLXXVIII. f. 455. a—c.
29. — *Lutulenta*, Hübn.	Hübn. Noct. Tab. 33. f. 159. (fœm.)
30. — *Decora*, Hübn.....	Hübn. Noct. Tab. 9. f. 45. (mas.)
31. — *Fimbriola*, Hübn.	Hübn. Noct. Tab. 132. f. 603. (mas.)
32. — *Birivia*, Hübn....	Hübn. Noct. Tab. 9. f. 42. (fœm.) Tab. 138. f. 631. (fœm.)
33. — *Grisescens*, Fab.‡	— — —
34. — *Fugax*, Ochs.....	Hübn. Noct. Tab. 9. f. 44. (mas.)
35. — *Renigera*, Hübn.§	Hübn. Noct. Tab. 82. f. 384. (mas.)
36. — *Dilucida*, Hübn.	Hübn. Noct. Tab. 82. f. 383. (mas.)
37. — *Lucipeta*, Fab. ...	Ernst, VI. Pl. CCXXXV. f. 341.
38. — *Pyrophila*, Fab.§	Ernst, VI. Pl. CCXXXV. f. 342. a.
39. — *Latens*, Hübn.§...	Hübn. Noct. Tab. 89. f. 419. (mas.) Tab. 117. f. 546. (mas.)

* Rusina, Stephens.

"*Palpi* ascending, densely squamous, with the terminal joint exposed, rather elongate, composed of three somewhat slender joints, the terminal one being most slender: the basal joint about half the length of the second and a little curved, the terminal one-third the length of the preceding, elongate, obtuse: *maxillæ* moderate. *Antennæ* deeply bipectinated in the males, the pectinations suddenly abbreviated towards the apex; ciliated in the females: *head* small, pilose: *thorax* not very stout, clothed with loose hair-like scales, subcrested: *wings* horizontal, entire; the *anterior* elongate, subtrigonate, narrowed at the base, with the shoulder a little rounded; *posterior* orbiculate-triangular, slightly excised towards the costa: *body* slender, tufted at the apex in the males: *legs* short, robust. *Caterpillar* subterranean: *pupa* short, spinose at the apex, subterranean."—*Steph. Illust. Brit. Ent.* II. 111.

Stephens gives but one British species, as belonging to this genus, *Bo. ferruginea*, Esper., quoted by Treitschke, as synonymous with *N. tenebrosa*, Hübn.

† Charæas nigra, *Steph.*

‡ Agr. Alis cinereis: maculis ordinariis pallidis, strigâque submarginali punctorum atrorum.

§ Graphiphora, Steph.

Genus

Genus 50. NOCTUA, *Treitsch.*

GRAPHIPHORA, Ochsen. (Steph.) GRAPHIPHORÆ, Hübn.

Obs. If instead of merely changing Ochsenheimer's name for this genus from Graphiphora to Noctua, out of compliment, as it seems to Schrank, and "a highly esteemed entomological writer in the *Allgemeinen Literaturzeitung*," —M. Treitschke had favoured us with good generic characters for the group of insects he has placed in it, he would have performed an acceptable service to Entomology: but all that he tells us is, literally, that these Moths have a tuft on the back (*Ruckenschopf*), that their anterior wings are deflexed and somewhat overlap each other when at rest, and are decorated with reniform spots, and markings resembling Oriental characters: that the larvæ are variegated, and have strongly marked lateral stripes, and live chiefly on the leaves of low plants, but not on their roots; and that the metamorphosis is subterranean!—Thirteen of the nineteen species enumerated by Treitschke, as constituting his genus Noctua, are comprehended in Stephens's genus Graphiphora, the characters of which we have already given in the note to the 19th species, *crassa*, of the preceding genus, Agrotis; to which we shall add, in this place, a few extracts from his observations on the Graphiphoræ. Like Agrotis, this genus, Stephens remarks, is chiefly composed of dingy and similarly marked species, though amongst them may be noticed a few of delicate and somewhat vivid colours: these two genera are evidently closely allied, and several of the species are included in the former by Ochsenheimer and Treitschke, while Schrank and Boisduval agree in uniting the whole under the incorrect appellation Noctua (a name which has also been employed by Treitschke in lieu of Graphiphora, as just stated, although justly restored by Savigny to a genus of Owls); they may, however, be distinguished by the superior width and glossiness of the wings, which have usually but two stigmata, and by the general simplicity of the antennæ.—*Steph. l. c.*

Species.	Icon.
1. N. *Ravida*, Hübn. ...	Ernst, VII. Pl. CCLXVI. f. 421.
2. — *Augur*, Fab.	Ernst, VI. Pl. CCLV. f. 388.
3. — *Sigma*, Hübn.....	Ernst, VIII. Pl. CCCXI. f. 542.
4. — *Baja*, Fab.....	Ernst, VIII. Pl. CCCXI. f. 540.

5. N. *Can-*

	Species.	Icon.
5.	N. *Candelisequa*, Hüb.	Hübn. Noct. Tab. 85. f. 397. (fœm.)
6.	— *Brunnea*, Fab. ...	Hübn. Noct. Tab. 26. f. 121. (mas.)
7.	— *Dahlii*, Hübn. ...	Ernst, VII. Pl. CCLXVIII. f. 428.
8.	— *Punicea*, Hübn...	Hübn. Noct. Tab. 25. f. 115. (fœm.)
9.	— *Festiva*, Hübn. ...	Ernst, VIII. Pl. CCCXI. f. 541.
10.	— *Polygona*, Fab. ...	Ernst, VII. Pl. CCLXVI. f. 423. a.
11.	— *Depuncta*, Linn...	Hübn. Noct. Tab. 26. f. 120. (mas.) Tab. 107. f. 502. (mas.)
12.	— *Rhomboidea*, Esper.	Ernst, VII. Pl. CCLXVII. f. 425. a.
13.	— *Gothica*, Linn.*...	Ernst, VII. Pl. CCLXVI. f. 422.
14.	— *C. Nigrum*, Linn.	Ernst, VII. Pl. CCLXVII. f. 424.
15.	— *Triangulum*, Ochs.	Ernst, VII. Pl. CCLXVII. f. 427.
16.	— *Tristigma*, Ochs...	Ernst, VII. Pl. CCLXVII. f. 425. b.
17.	— *Flammatra*, Fab.	Hübn. Noct. Tab. 26. f. 124. (mas.)
18.	— *Musiva*, Hübn....	Hübn. Noct. Tab. 25. f. 118. (mas.)
19.	— *Plecta*, Linn.....	Ernst, VII. Pl. CCLXV. f. 419.

Genus 51. TRIPHÆNA, *Ochs.* (Steph.)

Antennæ simple in both sexes, ciliated beneath in the males. *Palpi* ascending, compressed, parallel, triarticulate, the two basal joints clothed with very compact capitate scales, terminating acutely in front, the apical somewhat exposed; the basal joint shorter than the following, and curving upwards; the second as long as the other two, a little bent inwards towards the apex; the terminal short, rather slender, somewhat attenuated at the tip, which is obtuse: *maxillæ* very long.

* Semiophora[a], Steph.

"*Palpi* short, very hairy at the base, the terminal joint exposed and scaly; triarticulate, the basal joint slightly bent, stout, not half as long as the second, which is elongate, slightly attenuated, the terminal one minute, ovate, subtruncate: *maxillæ* as long as the antennæ. *Antennæ* bipectinated in the males, serrated in the females, each joint producing a bristle on both sides: *head* small, pilose: *thorax* stout, woolly, not crested: body not very stout, short: *wings* entire, slightly deflexed, *anterior* elongate, narrowed at the base, rather acute at the tip, *posterior* abbreviated, subtrigonate: *legs* short: *femora* woolly. *Larva* naked, exposed: *pupa* subterranean."—*Steph. Illust. Brit. Ent. Haust.* II. p. 138.

Stephens adds that this genus differs from Graphiphora and Agrotis by the woolliness of its smooth thorax, the brevity of the posterior wings, and by reposing with the anterior ones deflexed.

[a] Σημειον *signum*, φερω *fero*.

Wings horizontal, entire; *anterior* elongate-lanceolate, rounded posteriorly, with two stigmata; *posterior* orbiculate-triangular, slightly emarginated, large, folded during repose, of lively colours, usually luteous with black margins.

Head densely clothed with scales; *thorax* not crested, with large anterior tippets: *body* rather stout, flat on the back, downy at the base.

Larva naked, cylindric, with sixteen legs.

Pupa subterraneous, not folliculated*.

Species.	Icon.
1. Tr. *Interjecta*, Hübn.	Hübn. Noct. Tab. 23. f. 107. (mas.)
2. — *Comes*, Hübn.	Ernst, VII. Pl. CCLXXII. f. 435. c. f. g.
3. — *Subsequa*, Hübn....	Ernst, VII. Pl. CCLXXII. f. 435. a. d. e.
4. — *Pronuba*, Linn....	Ernst, VII. Pl. CCLXX. and CCLXXI. f. 433. c. d. e. i.
5. — *Innuba*, Treitsch.	Ernst, VII. Pl. CCLXXI. f. 434. f—h.
6. — *Fimbria*, Linn. ...	Ernst, VII. Pl. CCLXIX. f. 432.
7. — *Ianthina*, Fab. ...	Ernst, VII. Pl. CCLXX. f. 433.
8. — *Linogrisea*, Fab.	Ernst, VII. Pl. CCLXXII. f. 436.

Genus 52. AMPHIPYRA, *Ochs.*, *Treitsch.*

Pyrophilæ, Hübn.

Wings, *anterior* somewhat deflexed, half covering the body when at rest; surface glossy, rather inclining to a brassy hue, without distinct spots.

Antennæ long, pectinated; pectinations very short, so as to give the organ a crenate appearance.

Body compressed, obtuse; back smooth; small, lateral tufts of hair in the male.

Larva naked, or very slightly hairy.

Species.	Icon.
1. Amp. *Tragopogonis*, L.	Ernst, VI. Pl. CCXXXIV. f. 338.
2. — *Tetra*, Hübn. ...	Hübn. Noct. Tab. 8. f. 39. (fœm.)
3. — *Livida*, Fab.	Ernst, VI. Pl. CCXXXIII. f. 337. g. h.
4. — *Cinnamomea*, Borkh.	Ernst, VI. CCXXXIV. f. 339. a—e.
5. — *Pyramidea*, Linn.	Ernst, VI. CCXXXIII. f. 337.
6. — *Perflua*, Hübn....	Hübn. Noct. Tab. 8. f. 35. (fœm.)
7. — *Spectrum*, Hübn.	Ernst, VIII. Pl. CCCXX. f. 562.

* Characters from Stephens.

[To be continued.]

LIV. *Reply*

LIV. *Reply to* Mr. J. de C. Sowerby's *Remarks on "Experiments on the Pressure of the Sea at considerable Depths." By* Jacob Green, *M.D. Professor of Chemistry in Jefferson's Medical College, Philadelphia, United States.*

To Richard Taylor, Esq.

IN your valuable Magazine for July 1828, there appeared some remarks made by me, "On the Pressure of the Sea at considerable Depths;" and in the next Number J. de C. Sowerby, Esq. has favoured us with a kind of criticism on the communication. Now, although the subject is not a very important one, still no person feels satisfied with having his statements misrepresented, whether this be done through mere inadvertence, or in any other manner; I hope therefore you will allow me a word in reply.

The conclusion that I drew from my experiments was, "that at the depth of 230 fathoms, the water enters glass vessels through the stoppers and coverings which surround them, and not through the pores of the glass:"—not that the fact, that water will not penetrate glass at all, as Mr. S. says, has been so often proved before, but merely that it will not at the depth of 230 fathoms. Now if Mr. Sowerby had shown us that this fact had ever been proved before, his remarks would have been in point, and I should have thought my experiments of no value. The fact, however, never could have been proved without using a glass vessel *hermetically* sealed; and which, as far as my knowledge extends, never was done before. Mr. S. says, "Dr. Green thinks that by proving (*as others have done*) that the water would not penetrate glass, he has reduced the question to very narrow limits." Mr. S. should certainly have given us his authorities here; and until they are produced I shall consider my experiment as the first to settle the fact*.

The misrepresentation to which I have alluded is, that Mr. S. cites me as concluding that the water enters glass vessels through the "cork and all its coverings, in consequence of the vast pressure of superincumbent water, in the same manner as blocks of woods are penetrated by mercury in the pneumatic experiment of the mercurial shower." If any one will take

* In the Rev. Mr. Campbell's account of his second Missionary Journey in South Africa, published about seven years ago, at the end of the second volume, Dr. Green will find the particulars of an experiment made by Mr. Campbell with two globular bottles hermetically sealed. They were sunk to the perpendicular depth of 200 fathoms, and on being raised, they were found *empty;* thus proving, that, at this depth at least, water will not penetrate glass.—Edit.

the trouble to turn to the passage in your July Number, p. 37, he will see that I have given this as the opinion of other experimentalists, whose names and works are referred to at the bottom of the page. A considerable part of Mr. S.'s short communication is to show that water will not pass through a *cork* in the same manner as mercury through a block of *wood*,—an opinion which I never maintained. I can however inform Mr. S., that mercury in the pneumatic experiment of the mercurial shower will penetrate cork much in the same way as it does blocks of wood; and though not by *longitudinal tubes*, yet in a manner sufficiently analogous to justify the comparison made by the gentleman I have quoted.

Mr. S. concludes "from recorded experiments, that well-fitted glass-stoppers will exclude the water." Now, for the same reason, I conclude that they will not: and as I have some authority for the fact, besides my own experiment,—which, by the way, Mr. S. will not place among the *recorded*,—he must produce further evidence.

For myself, I am by no means satisfied with Mr. S.'s explanation of the phænomenon alluded to. How that part of the cork which is protected by the neck of the bottle from the *lateral* pressure of the sea should be diminished in its bulk or diameter by the perpendicular or superincumbent pressure, so as to be separated from the glass all around, is what I cannot understand. So far from getting the cork through the neck of the bottle, by Mr. S.'s mode of explanation it seems to me that we shall only wedge it in the tighter.

There is one part of the explanation proposed by Mr. S., which struck me as a new fact. It is as follows: "Even pitch when cooled in the deep water would be very brittle, and crack or separate from the bottle readily; and it would assume its former ductility and appearance upon returning through the warmer surface (*warmer medium?*). Now before this, I supposed that common pitch melted at about 150° Fahrenheit, and that the temperature of the ocean at a considerable depth was much colder than at the surface. Even at the equator the surface of the water is generally 80° Fahr., and it diminishes as the latitude increases. At a distance from land, where our experiments must be made, it also diminishes as the *depth* increases. In a *recorded* and authentic experiment, it was found that when the surface of the water was 40°, at the depth of fifty fathoms the thermometer stood at 25°*.

I could

* We are at all times happy to insert the replies of writers whose papers may have been the subjects of animadversion in our pages; but we think that some passages of Dr. Green's Reply to Mr. Sowerby, as above, require a few

I could say more, but I fear I have already taken up too much of your space with this subject. Yours truly,

Philadelphia, Dec. 17, 1828. JACOB GREEN.

LV. *On a Luminous Arch seen at Biggleswade on the 23rd of March. By Mr.* THOMAS MACLEAR.

To Mr. Taylor.

Sir,

ON Monday morning last (the 23rd instant), at $14^h\ 20^m$ sidereal time, I observed a luminous arch of white light extending itself from the eastern horizon, from the point E. by S. towards α Ursæ Majoris, and to within eight degrees of the meridian. It was four degrees broad at the horizon, gradually increasing to six at the altitude of forty. Its north edge accurately defined.

At $14^h\ 24^m$ α Lyræ was seen distinctly shining through its middle. It bifurcated at the altitude of 11°, diverging to 8° in breadth at the meridian, reaching δ Ursæ Majoris; the northern limb in the direction of Polaris.

The wind E. by N., very low.

A slight appearance of aurora borealis in the North, but rendered dim by the moonlight.

At $14^h\ 26^m$ divided into three branches: α Lyræ in the most southern.

At $14^h\ 30^m$ divided into four branches.

At $14^h\ 32^m$ divided into five branches. The spaces between the three northern very clear and well defined. α Lyræ on the south edge of the most southern.

At $14^h\ 35^m$ formed two beautiful arches, Polaris between them: α Lyræ 6° clear of the most southern.

A few streamers shooting from the West towards Polaris to about the altitude of 10°.

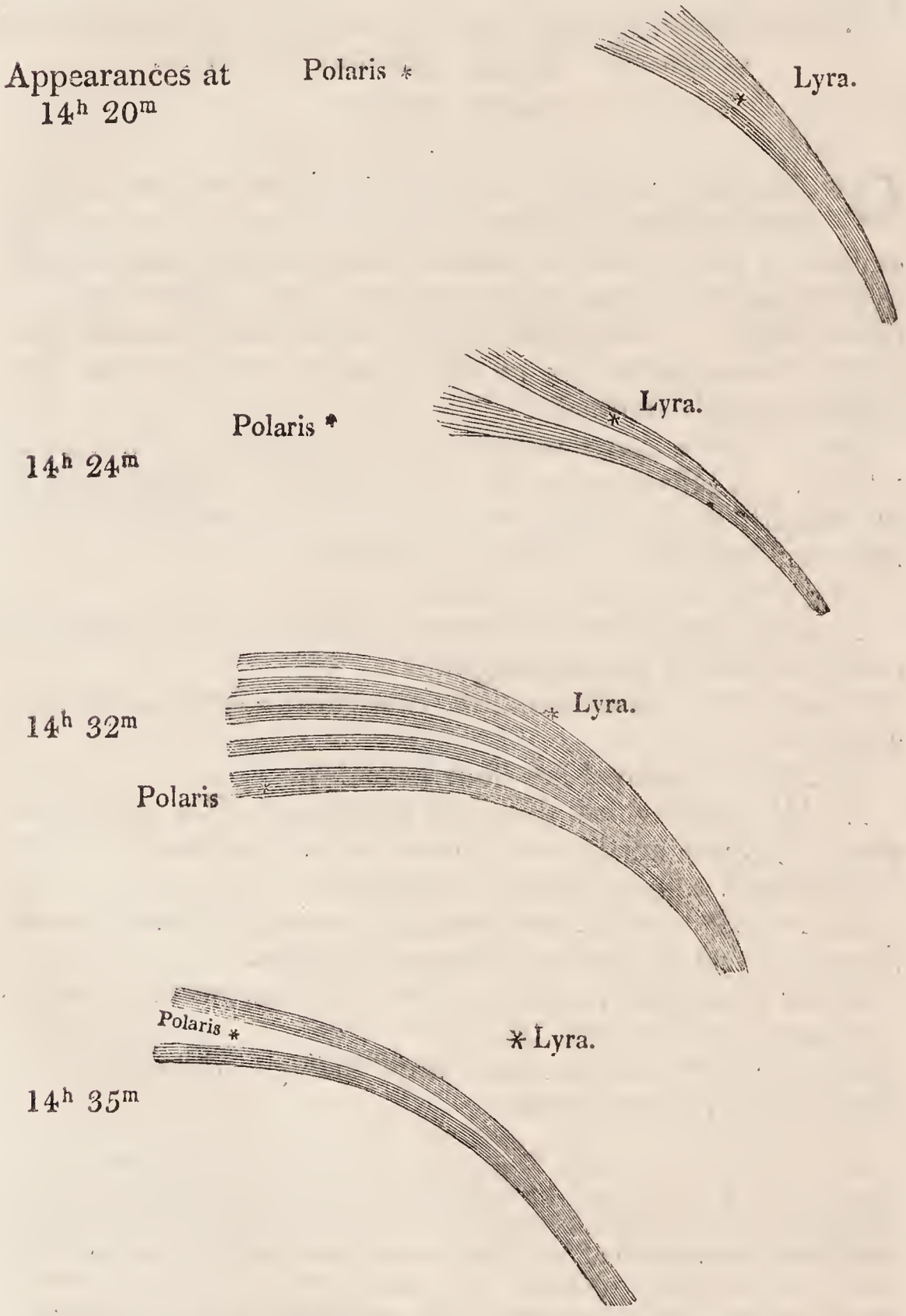
At $14^h\ 39^m$ the southern arch fading; white flocculent clouds obscuring the moon.

a few remarks from us. Mr. Campbell's anticipation of Dr. Green's experiment with a glass vessel hermetically sealed, has been noticed in preceding page; and Dr. G.'s observations on the cooling of the pitch by the diminished temperature of the deep water, tend, as it appears to us, to confirm Mr. Sowerby's opinion. The appearance and ductility of pitch at temperatures of moderate warmth only, are alluded-to by Mr. Sowerby, whose remark has no reference to its liquefaction; and the fact that the ocean at a considerable depth is much colder than at the surface, is the very ground of that gentleman's statement on this part of the subject. Some experiments with wine-bottles secured with pitch, &c. made by Mr. Campbell at the same time he sunk the globular bottles already mentioned, also appear to confirm Mr. Sowerby's observations.—EDIT.

At

At $14^h\ 42^m$ both arches gradually fading, and irregular near Polaris.

In the northern region there is a bland white light gradually mellowing off to 20° of altitude.



At $14^h\ 51^m{\cdot}5$ small brushes of light in the zenith in the direction of the meridian, and about 6° in length.

The arches disappearing. The sky generally hazy.

At $15^h\ 5^m$ the eastern and western horizons covered with a peculiar white hazy mass.

At

At $15^h\ 7^m$ an irregular halo round the moon.

Barometer in the Observatory 29·9 inches.
Thermometer in ditto ..... 42°
Thermometer out of ditto 36
Latitude 52° 5′ 25″.

Perhaps some of your numerous readers may have had an opportunity of witnessing the phænomenon, and can give a better account of it than the above.

I remain, yours, &c.

THOMAS MACLEAR.

Biggleswade, Beds. March 24, 1829.

LVI. *On the* Rev. W. Taylor's *Experiments on the Combustion of Coal-Gas, and on the best Form for Gas-burners. By Mr.* WILLIAM LOWRY, *Civil Engineer.*

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

IN your Number for February, I observe a notice intitled "New Experiments on the Combustion of Coal-Gas." The experiments are certainly not new; for in the years 1823 and 1824, having had occasion to examine the consumption of gas by different descriptions of Argand burners, I obtained some results, which appeared at first sight paradoxical, was led to vary the experiments in every way which seemed calculated to elucidate the subject, and in the course of my inquiries met with the facts mentioned in your Number alluded-to.

Previous to giving an account of my experiments, it may be necessary for those at least not intimately acquainted with the subject, to state that in each of them the flame was allowed to rise as high as would admit of the perfect combustion of the gas, and that the results of the experiments are not compared with one another, but with the light given out by a quantity of gas consumed with a given height of flame by burners of the ordinary construction.

Burners whose circle of holes were 5-8ths of an inch in diameter were tried with from five to fifteen holes in the circle, and the consumption was always the least with the greatest number of holes; though no great difference was observed when the holes were so near each other as to allow the jets to be perfectly united.

An enlargement of the holes also produced a saving. When the central air-aperture was stopped, or partially so, the flame rose considerably, but was conical and dull; but when the central

tral and outer apertures were proportionally reduced, the flame became bright and cylindrical.

On shortening the glass chimney, more light was obtained from a given quantity of gas; and on taking off the glass altogether, less gas was consumed in proportion to the light given out.

A perforated plate was laid on the top of the glass chimney, and the quantity of light was increased; and the same effect took place by using a glass whose diameter at top was equal to the openings found most advantageous in the perforated plate.

On doubling the height of the glass chimney, the flame fell to about one half of its former height.

As all these experiments (except the last, which is the converse of the rest) either reduce the quantity of air supplied to the burner, or bring the gas in a greater body in contact with that quantity, it appears to follow that a certain proportion of air is necessary to be supplied to the volume of gas emitted; and that should the proportion exceed a certain limit, the gas is consumed without giving out all the light it is capable of producing; the extreme of which is the explosive mixture, by which a large quantity of gas may be consumed in a moment, giving out almost no light. On the other hand, if too little air is supplied, the brilliancy of the flame is destroyed, and the gas passes off without being perfectly consumed. I was thus led to conclude, that the proper proportions lay between the two extremes; and the difficulty appeared to be, to determine the point most advantageous in œconomizing the gas consistent with the brilliancy of the flame; and my inquiries were accordingly directed to the construction of a burner which would combine the advantages of admitting the proper quantity of air, and at the same time bring the gas in the most favourable manner in contact with it. From various trials it seemed that the greatest effect was produced when the holes were numerous, and rather large than small, the central aperture narrow, and the glass near the flame; the outer aperture being in such proportion to the inner as to keep the flame cylindrical. This construction, however, when carried to the extreme, is attended with some practical disadvantages. Burners being often placed in exposed situations, the least motion of the air brings the flame in contact with the glass, in such a way as to produce smoke; and the glass being intensely heated, is more liable to be broken. I found it answered the purpose fully as well to enlarge the air aperture, making the glass-chimney rather wider and shorter, reducing in this manner the speed of the air through it. Accordingly when I constructed

structed gas-works for lighting Dumfries, in 1825, I had the burners made on the plan I have described; and experience has shown that they answer the purpose of requiring less gas than other burners, and giving at the same time as brilliant, and perhaps a more beautiful flame. Nor have I from any subsequent experiment found any cause for adopting a different construction. To alter the burners of a whole town would, however, be an expensive and troublesome process; yet in making the burners for Greenock (which town I have lighted within the last six months), I had an opportunity of introducing any improvement, had I seen occasion to alter the principle I had formerly adopted for Dumfries.

I am, Gentlemen, yours, &c.

Greenock, March 10, 1829. WILLIAM LOWRY.

LVII. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

Dec. 11th.—A paper was read, intitled, "On a method of comparing the light of the sun with that of the fixed stars." By William Hyde Wollaston, M.D. V.P.R.S. &c.

In the Philosophical Transactions for the year 1767, a suggestion is thrown out by Mr. Michell, that a comparison between the light received from the sun and any of the fixed stars might furnish data for estimating their relative distances; but no such direct comparison had been attempted. Dr. Wollaston was led to infer, from some observations which he made in the year 1799, that the direct light of the sun is about one million times more intense than that of the full moon, and therefore very many million times greater than that of all the fixed stars taken collectively. In order to compare the light of the sun with that of a star, he took as an intermediate object of comparison the light of a candle reflected from a small bulb about a quarter of an inch in diameter, filled with quicksilver, and seen by one eye through a lens of two inches focus, at the same time that the star or the sun's image, *placed at a proper distance*, was viewed by the other eye through a telescope. The mean of various trials seemed to show that the light of Sirius is equal to that of the sun seen in a glass bulb one-tenth of an inch in diameter, at the distance of 210 feet; or that they are in the proportion of one to ten thousand millions: but as nearly one-half of the light is lost by reflection, the real proportion between the light from Sirius and the sun is not greater than that of one to twenty thousand millions. If the annual parallax of Sirius be half a second, corresponding to a distance of 525,481 times that of the sun from the earth, its diameter would be 3·7 times that of the sun, and its light 13·8 times as great. The distance at which the sun would require to be viewed so that its brightness might be only equal to that of Sirius, would be 141,421 times its present distance; and, if still in the ecliptic, its annual parallax in longitude would be

nearly 3″; but if situated at the same angular distance from the ecliptic as Sirius is, it would have an annual parallax in latitude of 1·8″.

Dec. 18.—A paper was read, intitled, "An attempt to rectify the inaccuracy of two logarithmic formulæ." By J. T. Graves, Esq.; communicated by J. F. W. Herschel, Esq. V.P.R.S.

The discovery made by Poisson and Poinsot, during their recent researches on angular sections, of errors in trigonometrical formulæ usually deemed complete, drew the attention of the author to an analogous incorrectness in logarithmic series. He accordingly proposes, in the present paper, to exhibit, in an amended form, two fundamental developments; the principles employed in the establishment of which admit of application in expanding, by different methods, various similar functions, and tend also to elucidate other parts of the exponential theory. He then enters into an analytical investigation of the equation $a^x = y$; and exhibits correct developments; first, of y, in terms of a and x; and secondly, of x, in terms of a and y; the corresponding developments hitherto given being incomplete. He considers the principles employed in this inquiry as presenting a solution of many difficulties, and illustrating peculiarities appertaining to the theory of logarithms of negative quantities; and when applied to geometry, as furnishing the means of tracing the form and developing the properties of curves whose equations involve exponential quantities. He also states, that by their means various differential and other formulæ, usually exhibited in treatises on logarithms, may be rendered complete. An appendix is subjoined, containing several examples of these applications of his principles. In the course of his investigations, the author endeavours to explain the remarkable anomaly which frequently presents itself to the analyst of developments, in which, upon substituting a particular value for the variable in each, there is no approximation to numerical identity between the several resulting series calculated to any number of terms, and the respective functions which they ought to represent. He combats the paradoxical opinion which has been advanced, that equations which in particular instances were numerically false, were yet analytically true; and explains the difficulty by reverting to the limitations inherent in the hypothesis upon which the development is founded. He maintains, in opposition to the opinions of Jean Bernouilli and D'Alembert, that the logarithms of negative numbers are not in general the same as their positives; and hence infers, that negative numbers have occasionally even real logarithms. The chief novelty of his system consists in showing that any assigned quantity, relatively to a given base, has an infinite number of orders of logarithms, and an infinite number of logarithms in each order.

Another paper was read, intitled, "Experiments on the modulus of torsion." By B. Bevan, Esq.; communicated by the President.

The object of the author in this paper is to ascertain the modulus of torsion in different species of wood, and also of metals, deduced from experiments on a large scale, which he conceives will furnish many useful data applicable to practice by the mechanic and engineer.

Care

Care was taken that the specimens of wood which were the subjects of experiment were sound and dry, and free from any large knots; and their correct dimensions were ascertained by an improved kind of callipers. In every specimen two indexes were attached; one a few inches from the end fixed in the clamp, and the other at a small distance from the attachment of the lever to which the straining power was applied; and the length of the bar subjected to torsion was estimated by the distance of the points of attachment of the indexes. A pivot was fixed at the supported end of the bar, in the line of its axis. The author gives the following rule for finding the deflection of a prismatic shaft—namely, that it is equal to the product of the straining power into the square of the radius by which it acts, and into the length of the shaft divided by the modulus of torsion, into the fourth power of the side of the square shaft. He then gives a table of the modulus of torsion in different woods, which he finds to vary from about nine to thirty thousand pounds, and to follow nearly the order of the specific gravity. In the metals, the modulus of torsion is one-sixteenth of the modulus of elasticity.

"On the Water of the Mediterranean." By W. H. Wollaston, M.D. V.P.R.S.

The late Dr. Marcet, in his examination of sea-water, of which he has given an account in the Philosophical Transactions for 1819, had been unable, for want of a sufficient number of specimens of water taken at various depths in the Mediterranean, to draw any certain inference as to what becomes of the vast amount of salt brought into that sea by the constant current which sets in from the Atlantic through the Straits of Gibraltar, and which, on the evaporation of the water, must either remain in the basin of the Mediterranean, or escape by some hitherto unexplained means. In the hope of obtaining further evidence on this question, he had requested Captain Smyth, R.N. who was engaged in a survey of that sea, to procure specimens of water from the greatest accessible depths. The specimens collected by Captain Smyth were, in consequence of Dr. Marcet's death, given to other persons and applied to other objects. Dr. Wollaston, however, fortunately obtained the three remaining bottles of the collection. The contents of one of these, taken up at about fifty miles within the Straits, and from a depth of 670 fathoms, was found to have a density exceeding that of distilled water by more than four times the usual excess; and accordingly it left upon evaporation more than four times the usual quantity of saline residuum. The result of the examination of this specimen accords completely with the anticipation that a counter-current of denser water might exist at great depths in the neighbourhood of the Straits, capable of carrying westward into the Atlantic as much salt as enters into the Mediterranean with the eastern current near the surface. If the two currents were of equal breadth and depth, the velocity of the lower current need only be one-fourth of that of the upper current, in order to prevent any increase of saltness in the Mediterranean.

Feb. 5th.—A paper was read, intitled, "On the stability and capacity of rectangular floating bodies," being a continuation of a former

paper. By William Walker, Master R.N.; communicated by the President.

The author having shown in the former part of this paper, that the stability of compound vessels (see Phil. Mag. &Annals for April, p.301,) as far as depends upon their form, is a maximum when the displacement they produce by immersion in a fluid is equal to half their magnitude, purposes in the present communication to prove that the same theory is true of all rectangular vessels, whatever be their dimensions; and also the following proposition, namely, that when either the length or breadth, or the length and depth are given, the maximum of stability takes place when the ratio of the depth to the breadth is as one to two. He enters at some length into the mathematical investigation of both these propositions: he observes, however, that in the actual construction of ships, many considerations should be attended to, independently of the attainment of stability,—such as velocity of motion; to obtain which condition, it is necessary to give the vessel as much stability as possible, consistently with the least displacement, so that the resistance to the direct passage of the vessel through the fluid may be reduced to a minimum. When the quantity of materials for building a ship of a given length is given, the maximum of capacity will be obtained when her breadth is double her depth. When the breadth is given, by increasing the relative depth, the ship will, when immersed to half her magnitude, carry less sail at small angles of inclination, and *vice versâ*.

February 26th.—The reading of a paper was resumed and concluded, intitled, "On the reflection and decomposition of light at the refracting surfaces of media of the same and of different refractive powers." By David Brewster, LL.D. F.R.S. Lond. and Ed.

When white light is incident upon a surface which separates two different media, the portion that is reflected should, according to the Newtonian theory of light, preserve its whiteness, provided the thickness of either of the media exceeds the 80,000,000th of an inch. But, since the dispersive powers of bodies are different, it must follow, as a necessary consequence, that reflected light can never, under any circumstances, retain perfect whiteness, although the modification it experiences is not of sufficient amount to become sensible in ordinary experiments. The author, during his investigations of the laws of polarization for light reflected at the separating surface of different media, had occasion to inclose oil of cassia between two prisms of flint glass; and was surprised to find that the light reflected was of a blue colour. The fact was new, but might be readily explained upon the principle that, although the refractive density of oil of cassia greatly exceeds that of flint glass for the mean rays, yet the action of these two bodies is nearly the same on the less refrangible rays; hence it may happen that a larger proportion of the former than of the latter are transmitted, and the pencil formed by reflection will then appear blue. The partial decomposition thus effected in the incident rays will be the same in kind, though it may vary in degree, at different angles of incidence, and cannot, therefore, give rise to any variation of colour in the reflected rays, although they may differ

in

in intensity according to the obliquity of the incidence. By using different kinds of glass and of interposed fluids, the author obtained various analogous results, different rays of the spectrum being separated according to the prevalence in each particular case of one or other of the opposite actions exerted upon them by the solid and the fluid medium. The author directed his attention more particularly to those conditions in which the nearest approach could be made to a perfect equilibrium of all the forces which affect the incident rays. The solids which he employed in his experiments were two prisms of plate glass, of which the sections were right-angled isosceles triangles, and differing but very slightly in their refractive indices. The fluids were castor oil and balsam of capivi, the former having a less, and the latter a greater refractive power than the glass prisms; a thin film of either fluid being interposed between them. With castor oil, and within the limit of total reflection, the reflected light is yellow; on gradually diminishing the angle of incidence, it passes in succession through all the tints of three orders of colours, of which the details are presented in a table, exhibiting those which correspond to different angles of incidence. When the incident light is homogeneous, no colours are seen, but the reflected pencils have their maxima and minima of intensity, like the rays of thin plates, or the fringes of inflected light formed by homogeneous rays. When capivi balsam is employed as the fluid medium, the same orders of colours are obtained by reflection, but at smaller angles of incidence than with castor oil.

Having ascertained that, at a temperature of about 94 degrees, the mean refractive index of the balsam became equal to that of the glass prisms, the author examined the influence of a gradual elevation of temperature upon the colours of the inflected pencils, and found that no particular change marked the instant when the refractive density of the two media became equal, although, when the temperature was increased considerably, the tints entirely disappeared. Analogous results were obtained by employing prisms of obsidian instead of glass.

The author next engaged in more extensive series of experiments with various fluids interposed between glass prisms, and states their results in the form of a table, showing more especially the periods of colours produced at the separating surfaces by the different kinds of oils. He considers the facts which are there detailed as establishing the existence of reflecting forces at the confines of media of the same refracting power, and as proving, 1st, that the reflective and refracting forces in these media do not follow the same law; and, 2dly, that the force which produces reflection varies according to a different law in different bodies. The reflective forces of the solid and the fluid may be conceived to decrease in various ways: 1st, they may respectively extend to different distances from the reflecting surface, and decrease according to the same law; 2dly, they may extend to different distances, and vary according to a different law; and, lastly, they may extend to the same distance, and vary according to different laws. Whether the refracting forces follow the same law in solids and in fluids, it is extremely difficult to determine by direct experiment; but

but if we assume the mutual dependence of the refracting and reflecting forces, then the experiments recorded in this paper will establish a variation in the law of the refracting forces of different media. The facts may be explained on the undulatory theory of light, by supposing that the density or elasticity of the ether varies near the surface of different bodies,—an hypothesis which has already afforded an explanation of the loss of part of an undulation in several of the phænomena of interference; the part lost being, according to Dr. Young, a variable fraction depending on the nature of the contiguous media.

The phænomena of periodical colours at the confines of media of the same or of different refractive powers, are evidently dependent on the law of interference; although it may be difficult to point out the precise mode in which they are produced. In combinations where there is much uncompensated refraction, their production is influenced by certain changes, such as the formation of a thin and invisible film on the surface of the solid, the nature and origin of which the author endeavours to investigate, but which he acknowledges he has hitherto been unable to discover. That some unrecognised physical principle is the cause of all these phænomena, will, he thinks, appear still more probable from a paper which he intends to present to the Society, on the production of the very same periods of colour at similar angles of incidence by the surfaces of metals and transparent solids when acting singly upon light.

March 5.—A paper was read, intitled, "Anatomical description of the foot of a Chinese female." By Bransby Blake Cooper, Esq.; communicated by P. M. Roget, M.D. Sec. R.S.

The foot, of which an account is here given, was obtained from the dead body of a female found floating in the river at Canton, and had all the characters of deformity consequent upon the prevailing habit of early bandaging for the purpose of checking its natural growth. To an unpractised eye it has more the appearance of a congenital malformation, than of being the effect of art, however long continued; and appears at first sight like a club foot, or an unreduced dislocation. From the heel to the great toe the length of the foot measures only four inches; the great toe is bent abruptly backwards, and its extremity pointed directly upwards; while the phalanges of the other toes are doubled-in beneath the sole of the foot, having scarcely any breadth across the foot where it is naturally broadest. The heel, instead of projecting backwards, descends in a straight line from the bones of the leg, and imparts a singular appearance to the foot, as if it were kept in a state of permanent extension. From the doubling-in of the toes into the sole of the foot, the external edge of the foot is formed in a great measure by the extremities of the metatarsal bones; and a deep cleft or hollow appears in the sole across its whole breadth. The author gives a minute anatomical description of all these parts, pointing out the deviations from the natural conformation. He remarks, that from the diminutive size of the foot, the height of the instep, the deficiency of breadth, and the density of the cellular texture, all attempts to walk with so deformed a foot must be extremely awkward; and that in order to preserve an equilibrium

equilibrium in an erect position, the body must necessarily be bent forwards with a painful effort, and with a very considerable exertion of muscular power.

March 26.—A paper was read, intitled, "An experimental inquiry into the physiological effects of oxygen gas upon the animal system." By S. D. Broughton, Esq. F.G.S.; communicated by B. C. Brodie, Esq.

Although it has long been known that the respiration of pure oxygen gas is destructive to life, some differences of opinion have existed with respect to the physiological conditions of the animals subjected to its influence; and also with regard to the quantity of oxygen consumed under these circumstances, compared with that consumed by the respiration of atmospheric air. With a view to elucidate some of these points, the author confined rabbits, guinea-pigs, and sparrows, in glass jars inverted over water, containing oxygen gas, obtained from black oxide of manganese by a red heat. The animals at first appeared to suffer no inconvenience from the respiration of the gas; but after some time, generally in about an hour, their breathing became hurried, and their circulation accelerated. This state of excitement was followed by an opposite one of debility; the respirations became feeble, and were more slowly performed; loss of sensibility and of the power of voluntary motion gradually supervened, till the only remaining visible action was a slight one of the diaphragm, occurring at distant intervals. On opening the body, under these circumstances, and also after the entire cessation of the movements of the diaphragm, the breast was found to be still in vigorous action; the blood in every part of the vascular system, both venous and arterial, was of a bright scarlet hue; it was remarkably thin, and rapidly coagulated; and the temperature of the body continued undiminished. If before the diaphragm has ceased to act, the animal is removed from the vessel to the open air, it generally either recovers spontaneously, or its animation may be restored by artificially inflating the lungs with atmospheric air. The author found that the gas in which animals had thus been confined till they died, retains its power of rekindling a blown-out taper, and of sustaining for a time the life of another animal introduced into it; and he hence deduces the inference, that it does not contain so great an excess of carbonic acid as the gas left when animals have perished by confinement in atmospheric air. He considers the train of symptoms induced by the respiration of pure oxygen gas as analogous to those which follow the absorption of certain poisons into the system.

March 12.—A paper was read, intitled, "On the reduction to a vacuum of the vibrations of a pendulum in air." By Captain Sabine, R.A. Sec. R.S.

March 19th.—Captain Sabine's paper On experiments made with the pendulum *in vacuo*, was resumed and concluded.

April 2.—A paper was read, intitled, "On the physiology of the nervous system." By Dr. A. P. Wilson Philip, F.R.S.

April 9th.—Dr. Wilson Philip's paper On the physiology of the nervous system was resumed and concluded.

LINNÆAN SOCIETY.

March 17th.—The reading of Mr. David Don's Descriptions of the new genera and species of the class *Compositæ*, belonging to the Floras of Peru, Chili, and Mexico, was resumed and concluded.

The extensive herbaria formed by Ruiz and Pavon, in Peru and Chili, and those collected in Mexico by Sessè and Mociño, having fortunately for science come into the possession of A. B. Lambert, Esq. V.P.L.S. it is Mr. Don's intention in this paper to give descriptions of the plants belonging to the class *Compositæ*, amounting to 1000 species, and which constitute an important part of these collections, the greater portion of which still remain unpublished, notwithstanding the important labours of Humboldt and Bonpland, and other botanists, who have treated of the plants of the late Spanish possessions in America. The author has given a general view of the structure and affinities of the *Compositæ*, numerous remarks on the various groups and families of which this extensive class is composed; and also some observations on their general geographical distribution.

April 7.—Mr. Brookes exhibited a living specimen of *Lacerta ocellata* from St. Michael's.

Read a communication from the Rev. P. Keith, On the Origin of Buds.

April 21.—A further portion was read of the paper intitled, A Catalogue of Sicilian Plants; by John Hogg, Esq. M.A. F.L.S.; which consisted of some observations on the geology of Sicily.

GEOLOGICAL SOCIETY.

Jan. 16.—An Appendix was read to Mr. De la Beche's paper, on the Geology of Nice, by the Rev. W. Buckland, D.D. &c. &c. &c.

After bearing testimony to the correctness of the description given by Mr. De la Beche of the immediate neighbourhood of Nice, the author communicates his own observations made along the high road from that city to the Col de Tende, for the distance of about fifty miles.

The hill on the south of Scarena, twelve miles N.E. of Nice, presents a section of the green-sand formation, with nummulites, turrilites, and its other usual fossils, alternately with compact gray-limestone destitute of fossils. At Mont Brause the same beds of green-sand occur loaded with ammonites and belemnites.

On the descent to Sospello are found, in a regular descending series, green-sand, Jura, oolitic (or younger Alpine) limestone, lias, red-marle, and older Alpine limestone or dolomite, abounding in rauchwacke, and with vast beds of gypsum; on the N. of Brais mountain, is a similar section, at least 1500 feet in thickness.

In approaching the primitive chain we find in the vale of the Roya various beds of the new-red-sandstone formation, loaded, near Scorglio, with pebbles, (rothe-todte-liegende); and three miles beyond, at La Fontana, this conglomerate rests on a coarse red micaceous grauwacke, which is succeeded by primitive rocks.

From hence the author infers, that the lower part of the calcareous deposit

deposit near Nice, is the older Alpine limestone; as is the opinion of M. Risso. On the authority of that gentleman, Professor Buckland remarks, that near the source of the Var the older Alpine limestone contains gypsum, with sulphur and salt springs; and he thinks it probable, that the gypsum found near Vinaigre and Requiez, and at Cimiez, belongs to this formation, rather than to the younger Alpine limestone, to which Mr. De la Beche refers it. A similar developement of the new red sandstone is seen between Toulon and Frejus, accompanied with gypsum, saccharine dolomite, rauch-wacke, and conglomerate.

The author repeats, what he has advanced elsewhere, that although limestone of all ages is occasionally more or less dolomitic, yet it is peculiar to that of the new-red-sandstone formation, to be so very decidedly, and almost invariably. He dissents altogether from the theory which ascribes the magnesia contained in the calcareous beds of the Tyrol to the proximity of trap rocks; since he cannot conceive that strata many hundred feet thick, and many miles distant, so far as is known, from any pyroxenic rock, have derived from such rocks their magnesian character;—particularly as the beds, which are magnesian, are found not unfrequently to alternate with calcareous beds that are not so.

Jan. 16.—A Letter was read, addressed to the President of the Society, by MM. Von Oeynhausen and Von Dechen, containing Observations on the mountain Ben Nevis, and on some other places in Scotland.

The authors of this communication, two Prussian naturalists, have here presented their observations on some of the more interesting portions of Scotland, which they visited about three years ago, with a view to a comparison of the rocks of Great Britain with those of the continent.

1. The paper commences with a description of the great barrier of the Caledonian Canal: High mountains of crystalline rocks form its western boundary; conglomerate and sandstone, with subordinate beds of black calcareous shale, reach from the east to the upper end of Lochness; on the banks of the river of that name, is a flat pebble beach 150 feet higher than the sea, portions of which form islands that have the aspect of old fortifications.

Ben-Nevis is wholly crystalline: its summit consists of felspar-porphyry; its sides of granite, which rises to the height of 3000 feet above the sea, and is bordered by gneiss and mica-slate.

Near Inverlochy Castle, a low rock projecting above the surface of the bog, consists of mica-slate, alternating, as in the valley of the Spean, with gray granular limestone.

On the N. of Ben-Nevis, sienite containing mica and hornblende, both of them black, and therefore easily confounded, forms below the granitic declivity a narrow ridge nearly 1000 feet high.

On the right bank of Glen-Nevis, the schistose rocks are lower towards the west, and repose on the steep side of the granite, small hollows, however, intervening; they soon disappear on the north, but gain ground eastward.

A single summit only, of Glen-Nevis, consists of mica-slate; beneath

are chlorite slate, and a rock composed of alternate laminæ of compact white felspar and green mica; in the hollow below is contorted gneiss, connected intimately with the rock just described, or rather passing into it.

Compact white, and pale-green felspar occurs frequently in the slates, at and near their junction with the granite.

The granite at the sides of Ben-Nevis is large-grained, composed of flesh-coloured felspar, albite, gray-quartz, and black mica in equal proportions; higher up, it loses the albite and quartz, acquires a few specks of hornblende, and passes into a kind of felspar-porphyry; which last-mentioned substance constitutes the summit.

The junction of the granite and porphyry is laid bare on the E. and S. sides of the mountain; but on the N. and W. is concealed by scattered blocks of porphyry.

At the head of Glen Ptarmigan, is a steep cliff of porphyry, at least 1500 feet high. Its shape is that of an oblique four-sided pyramid, irregular and truncated, rising on the east and south, *through* the granite; and not merely overlying it, as M. Boué supposed. This fact the authors consider themselves as having fully established.

With equal confidence they affirm, that the gneiss and mica-slate are not conformable to the granite; and that the latter has forced its way through them: the granite traverses them also in the form of veins.

They remark further, the frequent occurrence of compact felspar, where these substances adjoin the granite.

2. The mountains N. of Ben-Nevis are chiefly mica-slate: S.E. of Loch Lochy this rock passes into gneiss; on the sides of Glen Gloy, Glen Tuntick, and Glen Roy, it contains garnets, and alternates with quartz rock; in the valley of the Spean it is interstratified with granular limestone.

Felspar, porphyry, and greenstone occur, in the mica-slate, in Glen Gloy, in Glen Roy, at Caldivan, and in the valley of the Spean.

The S. shore of Glen-Nevis, near Ballahulish, is a granitic aggregate of felspar and mica; with concretions of mica and hornblende: granite occupies the low ground; gneiss succeeds, passing eastward, into mica-slate and clay-slate, in which are beds of roof-slate alternating with, and traversed by, greenstone dykes, and interstratified with granular limestone.

In Glen Coe mica-slate is cut through obliquely by compact felspar-porphyry; in the bed of the river is a fine-grained granite, with concretions like those of Ballahulish; the granite is succeeded by gneiss at a lower level, and at a higher, by compact felspar, speckled and veined with epidote.

3. On the Isle of Sky the authors offer the following observations:

The syenite lies upon the hyperstene rock; the passage into which is not gradual, but abrupt; the hyperstene rock passes into compact greenstone, and often skirts the syenitic mountains; the lias rests on syenite, or forms detached outliers; and this observation holds good invariably.

There is no such thing as a vein of syenite in the lias. The transmutation of lias into white granular and compact limestone is more

constant

constant at its junction with syenite, than with greenstone or trap; in the latter case it sometimes varies, sometimes not,—a circumstance difficult to account for.

The hyperstene rock seldom adjoins the lias; when it does, like greenstone or trap, it both intersects and covers it.

Although the authors make a distinction between the rocks of syenite and those of trap and hyperstene, on account of their position relatively to the stratified rocks, they do not ascribe to the former a higher antiquity than to the latter; for the syenite must be the production of a later æra than the lias, since it has materially altered it.

Feb. 6th.—A paper was read, "On the discovery of a new species of Pterodactyle; and also of the Fæces of the Ichthyosaurus; and of a black substance resembling Sepia, or Indian Ink, in the Lias at Lyme Regis;"—by the Rev. W. Buckland, D.D. F.R.S. Professor of Mineralogy and Geology in the University of Oxford.

1.—This specimen of Pterodactyle was discovered, in December last, by Miss Mary Anning, and was found to belong to a new species of that extinct genus, hitherto recognized only in the lithographic Jura-limestone of Sollenhofen,—which the author considers as nearly coeval with the English chalk.

The head of this new species is wanting, but the rest of the skeleton, though dislocated, is nearly entire; and the length of the claws so much exceeds that of the claws of the Pterodactylus-longirostris and brevirostris, of which the only two known specimens are minutely described by Cuvier, as to show that it belongs to another species,—for which the name of *Pterodactylus macronyx* is proposed. A drawing of this fossil by Mr. Clift accompanies the paper. The author had for some time past conjectured, that certain small bones found in the lias at Lyme Regis, and referred to birds, belong rather to the genus Pterodactyle. This conjecture is now verified. It was also suggested to him, in 1823, by Mr. J. S. Miller of Bristol, that the bones in the Stonesfield-slate, which have been usually considered as derived from birds, ought to be attributed to this extraordinary family of flying reptiles: Dr. Buckland is now inclined to adopt this opinion, and is disposed to think still further, that the coleopterous insects, whose elytra occur in the Stonesfield-slate, may have formed the food of those insectivorous Pterodactyles. He conceives also, that many of the bones from Tilgate Forest, hitherto referred to birds, may belong to this extinct family of anomalous reptiles: and, from its presence in these various localities, he infers that the genus Pterodactyle was in existence, throughout the entire period of the deposition of the great Jura-limestone formation, from the lias to the chalk; expressing doubts as to the occurrence of any remains of birds before the commencement of the tertiary strata.

2.—*Fossil Fæces of the Ichthyosaurus.*—The author concludes from an extensive series of specimens, that the fossils, locally called Bezoar-stones, that abound at Lyme, in the same beds of lias with the bones of Ichthyosaurus, are the fæces of that animal. In variety of size and form they resemble elongated pebbles, or kidney-potatoes, varying generally from two to four inches in length, and from one to two inches

in diameter; some few being larger, others much smaller:—their colour is dark gray; their substance, like indurated clay, of a compact earthy texture; and their chemical analysis approaches to that of album græcum. Undigested bones and scales of fishes occur abundantly in these fæcal masses. The scales are referable to the Dapedium politum, and other fish that occur in the lias; the bones are those of fish, and also of small Ichthyosauri. The interior of these bezoars is arranged in spiral folds; their exterior also bears impressions received from the convolutions of the intestines of the living animals. In many of the entire skeletons of young Ichthyosauri, the bezoars are seen within the ribs and near the pelvis: these must probably have been included within the animal's body at the moment of his death. The author found, three years ago, a similar ball of fæcal matter, in the collection of Mr. Mantell, from the strata of Tilgate Forest, which abound in bones of Ichthyosauri and other large reptiles; and he conjectures that these bezoars exist wherever the remains of Plesiosauri are abundant.

3.—*Fossil Sepia.*—An indurated black animal substance, like that in the ink-bag of the cuttle-fish, occurs in the lias at Lyme Regis; and a drawing made with this fossil pigment, three years ago, was pronounced by an eminent artist to have been tinted with Sepia. It is nearly of the colour and consistence of jet, and very fragile, with a bright splintery fracture; its powder is brown, like that of the painter's Sepia; it occurs in single masses, nearly of the shape and size of a small gall-bladder, broadest at the base and gradually contracted towards the neck; these are always surrounded by a thin nacreous case, brilliant as the most vivid Lumachella; the nacre seems to have formed the lining of a fibrous thin shelly substance, which together with this nacreous lining was prolonged into a hollow cone like that of a belemnite, beyond the neck of the ink-bag; close to the base of the ink-bag there is a series of circular transverse plates and narrow chambers, resembling the chambered alveolus within the cone of a belemnite; but beyond the apex of this alveolus, no spathose body has been found.

The author infers, that the animal from which these fossil ink-bags are derived, was some unknown cephalopode, nearly allied in its internal structure to the inhabitant of the belemnite; the circular form of the septa showing that they cannot be referred to the molluscous inhabitant of any nautilus or Cornu-ammonis.

Feb. 6th.—A paper was read "On the Oolitic District of Bath," by William Lonsdale, Esq., of Bath-Easton.

The tract described in this paper comprehends a space included between the lines passing,—on the north, from Wycke north-west of Bath, through Marshfield, Kingston-St. Michael, and Lynham, to the Chalk-downs north of Calne and Cherhill; and on the south and south-east,—from the south of Radstock, through Frome and Westbury to Devizes. The author refers to the works of Mr. Smith, and of Messrs. Conybeare, De la Beche, and Phillips, as the principal published authorities on the district; and states his obligations for much valuable information to the Rev. B. Richardson of Farleigh, near Bath.

The

The geological boundaries of this tract are, on the west and north-west, the lias; on the south-east and east, the Chalk-downs, extending from Salisbury Plain near Westbury to near Urchford, and thence to Cherhill-hill on the east of Calne. The series of strata which it includes, being the following, in a descending order.—

Strata.	*Thickness.* Feet.	*Strata.*	*Thickness.* Feet.
Lower chalk		Forest marble (continued)	
Chalk marl	150	clay	10
Upper green-sand	75	coarse oolite	25
Gault	150	sandy clay and grit	10
Lower green-sand	50	Bradford-clay	50
Kimmeridge-clay.....	150?	great oolite	140
Upper calcareous grit....	10	fullers-earth	150
Coral rag.....	40	Inferior oolite	
clay	40	sandy oolite ... 60	
calcareous grit	50	sand and grit ... 70	
Oxford clay	300?	—	130
Kelloway rock....	5	marlstone	10
Cornbrash	16	Lias; upper marl.... 200	
Forest marble		blue lias 50	
clay	15	white lias 10	
sand and grit	40	lower marl 20	
		—–	280?

The surface of the country described in this paper is characterized by three ranges of hills connected by two plains.—1. The most western ridge is that of the great oolite, the highest part of which is 813 feet above the sea. It is separated, by the plain of the Oxford clay, from —2. The range of the coral rag; which again is detached, by the valley and plain of the Kimmeridge-clay and gault, from—3. The range of Chalk-hills.

The author describes in succession the several members of the series above mentioned: giving for each stratum an account of the range and boundaries, a general type of the succession and proportion of the component beds, with a detail of the physical characters and local peculiarities and names, and an enumeration of the organized remains, detailing the species of the fossils, with their localities and references to published figures. These copious details do not admit of abridgement.

The paper is illustrated by the corresponding sheets of the Ordnance-map, so far as they have been hitherto engraved, coloured geologically; and by several sections explanatory of the succession of the strata, and of the forms of the surface.

FRIDAY-EVENING PROCEEDINGS AT THE ROYAL INSTITUTION OF GREAT BRITAIN.

March 27th.—On the Motion of Sap in Plants; by Mr. Burnett. Mr. Burnett's principal objects were to develope and illustrate the late researches of Dutrochet on Endosmose and Exosmose, or the determination of currents of fluids through membranes, either in one direction

direction or the other, according to particular circumstances; and also the probable explanation which such phænomena afforded of the absorption of fluids by plants, and the ascent of the sap in their vessels. It is a fact discovered by M. Dutrochet, that if part of the cæcum of a chicken be tied into a bag, and then attached to the end of a tube, if the bag and a little of the tube be filled with a solution of gum, sugar, or several other substances; and if being so filled, the bag be immersed in water, the water will pass from the outside to the inside, will increase the quantity of fluid there, and will raise its level much above the level of the water without. This determination of the fluid from without inwards is called Endosmose. Some substances cause a contrary current, and then the term Exosmose is applied. The effects produced by various substances and in various ways were illustrated experimentally at the lecture-table. M. Dutrochet refers this influence altogether to electricity, and considers it as a principal power in causing the ascent of sap in plants. He admits only another, which is supposed to reside in the leaves at the upper ends of the vessels, and which may be assimilated to the action of an air-pump. In pointing out the extent and influence of these phænomena in nature, Mr. Burnett stated his opinion, that though powerfully influential in causing the entrance of water into the plant, yet Endosmose was not by itself, or in conjunction with the action of the leaves, sufficient to explain the phænomena of ascent in the vessels; and he described several experiments in which the influence of both powers being removed, still the ascent took place. Thus, when the root and the leaf were removed from a celery stalk, and the latter immersed in a coloured solution, the solution still ascended the vessels of the plant. Again, when roots were put into strong solutions of gum and sugar, such as, with reference to the quality of the sap in the vessels, should have caused the Exosmose or passage of the fluid out of the vessels, still the natural effect was undisturbed.

April 3rd.—On this evening Mr. Faraday, in Mr. Wheatstone's name, concluded the series of experimental investigations and illustrations which have been brought forward on former occasions in the theatre of the Institution, On the Resonance, or reciprocated Vibrations of Volumes of Air. The details this evening related principally to the effects produced by the reciprocated vibrations of the volumes of air in the mouth and the cavities of the ears, when they are nearly or altogether closed. The important influence of multiple reciprocated vibrations in affecting the quality of a sound supposed to be simple, but in reality consisting of several simultaneous accordant sounds, was stated, and exemplified by experiment.

When illustrating the curious effects produced by closing the cavities of the ears, and causing the volumes of air so insulated to reciprocate to the vibrations communicated through their side, amongst other things the Microphone of Mr. Wheatstone was described and shown, and its use in detecting the vibrating condition of any part of a sounding body, as a plate, or the sound-board of an instrument, or even the locality of a loose screw in a machine, fully demonstrated.

During the evening a striking illustration was given of the possi-

bility

bility of producing two simultaneous sounds by the mouth; in the whistling of an air first as a solo, and then as a duet. The gentleman who has this power has such command of the mouth, that the evidence of two coexisting sounds could not for a moment be doubted by the hearers.

April 10th.—Mr. Ainger completed his account of the development of the Origin and early History of the Steam-engine. As before stated, he differs much from M. Arago in his conclusions; but as we have reason to believe that his account, with the diagrams of proof attached to it, will be published, we shall not do injustice to either party by mutilating the evidence here.

The meetings of the Royal Institution were then adjourned over the 17th and 24th, to be resumed on May 1st.

ROYAL SOCIETY OF EDINBURGH.

(Extract from a Letter from the Trustees of the late Alexander Keith, Esq.)

"As the Royal Society of Edinburgh is the principal scientific establishment in Scotland, we hereby offer to its President and Council the sum of 600*l.*, the principal of which shall on no account be encroached on; while the interest shall form a biennial prize for the most important discoveries in science made in any part of the world, but communicated by their author to the Royal Society, and published for the first time in their Transactions. With regard to the form in which this prize is to be adjudged, we beg leave to suggest that it may be given in a gold medal not exceeding 15 guineas value, together with a sum of money, or a piece of plate bearing the devices and inscriptions on the medal."

The above-mentioned sum has been paid over to the Treasurer of the Royal Society of Edinburgh; and the prizes will be awarded at the specified periods, if any discoveries of sufficient importance be presented during their currency.

LVIII. *Intelligence and Miscellaneous Articles.*

THE LATE EXPEDITION UNDER CAPTAIN FRANKLIN.

THE Geographical Society of Paris have presented their annual Gold Medal, of the value of one thousand francs, to Captain Franklin, as a testimony of their sense of the importance of his second Expedition to the shores of the Polar Sea. The letter announcing this honour is so creditable to the taste and good feeling of the Geographical Society, and so gratifying in a national point of view, that, having earnestly solicited permission to publish it, we have great satisfaction in placing it before our readers.

"*Société de Géographie.—Commission Centrale.*

"Monsieur le Capitaine, "Paris, 30 Mars 1829.

"La Société de Géographie de Paris, dont le but est d'encourager les découvertes utiles, et de contribuer principalement aux progrès des sciences géographiques, a fondé un prix annuel en faveur du voyageur qui

qui aura fait en géographie une découverte marquante, et jugée la plus importante parmi celles qui seront parvenues à sa connaissance.

" Les dernières années ont été fécondes en découvertes d'une haute importance ; mais parmi toutes les conquètes faites à la science par les voyageurs de toutes les nations, et achevées pendant le cours de l'année 1827, la Société a distingué sur tout votre seconde expédition vers la Mer Polaire. Ce voyage est connu de toute l'Europe ; son mérite et ses résultats sont justement appréciés et honorés de l'approbation générale, depuis la publication savante que les a faits connaitre.

" Nous nous estimons heureux, Monsieur le Capitaine, de pouvoir vous annoncer que la Société, dans sa séance générale du 27 courant, vous a decerné le prix annuel, qui consiste en une médaille d'or de la valeur de mille francs.

" En vertu de ses réglemens, elle vous a inscrit, Monsieur, sur la liste de ses Correspondens Etrangers. Sans doute une palme aussi modeste ne peut rien ajouter à votre gloire; en vous la décernant, la Société ne fait que proclamer un suffrage que vous avez déjà reçu dans les deux mondes.

" Nous nous félicitons d'être, en cette circonstance, les interprètes des sentimens de la Société, et de pouvoir vous offrir l'assurance de la considération distinguée avec laquelle nous avons l'honneur d'être, Monsieur le Capitaine,

" Votre très humbles et très obéissans Serviteurs, les Présidens et Secrétaires de la Société et de la Commission Centrale.

" B : G. Cuvier, President.

" Larenaudiere, Girard. Jomard, Pres. de la Com. Cale.
Sre Gal. Rossel. Simeon, Vice President."

A Monsieur John Franklin, Capitaine de Vaisseau de la Marine Royal d'Angleterre, &c.

GLUCINUM AND YTTRIUM.

M. Wohler has succeeded in obtaining these metals from their oxides. The glucina employed had been dissolved in carbonate of ammonia; it was then intimately mixed with charcoal and heated to redness in a current of dry chlorine gas; the resulting chloride was procured by sublimation in the state of shining colourless needles, and also in a fused mass: it is very deliquescent, and dissolves in water with the disengagement of violent heat.

Glucinum was obtained from the chloride by putting it into a platina crucible with flattened pieces of potassium; the crucible was effectually covered, and heated with a spirit-lamp: the reduction takes place instantaneously, and with so great an evolution of heat that the crucible becomes white—hot; the crucible when cold was opened, and inverted in a vessel of water: the fused mass of chloride of potassium and glucinum dissolved with a slight evolution of sulphuretted hydrogen, and the glucinum separated in the state of a gray-black powder, which was washed on a filter and dried: this substance has perfectly the appearance of a metal precipitated and very finely dried; by burnishing it acquires a dark metallic lustre. As it does not agglutinate at the violent heat at which it

it is reduced, it would seem to be very difficult of fusion; at common temperatures it neither oxidizes in air nor water, not even when the water is boiling.

When heated on platina foil it inflames with great splendour, and becomes colourless glucine; but to produce this effect it must be heated to redness: in oxygen gas it burns with extraordinary splendour, and yet the resulting glucine evinces no trace of fusion: if it is mixed with hydrate of glucine, (which happens when too much potassium is employed in the reduction,) a flame is perceived during its combustion in the oxygen gas, arising from the hydrogen which is disengaged during the action of the glucinum upon the water.

When heated in sulphuric acid it dissolves, with the evolution of sulphurous acid gas: it readily dissolves in the sulphuric, muriatic, and nitric acids; and also in a solution of potash with the evolution of hydrogen. Unlike aluminum, it is not acted upon by ammonia: when moderately heated in chlorine it burns with great splendour, and sublimes as a crystallized chloride: when heated in the vapour of bromine it burns with equal facility, and the bromide of glucinum sublimes in long white needles: it is fusible, very volatile, and dissolves in water with great heat. Heated in the vapour of iodine, it burns in the same manner, and the iodide obtained sublimes in white needles; in other respects it is similar to the preceding. It readily forms compounds also with sulphur, selenium, phosphorus, and arsenic.

Yttrium was procured from yttria in the manner above described with respect to glucinum; its texture is scaly, its colour gray-black, and lustre perfectly metallic; the scaly texture distinguishes it from aluminum and glucinum. Its colour and metallic appearance are inferior to those of aluminum; one being to the other about as iron to tin. Aluminum appears to be a ductile metal, and yttrium on the contrary a brittle one: the latter at common temperatures is not oxidized either in the air or in water; but when heated to redness it burns with splendour, and becomes yttria. In oxygen gas the combustion is of the most brilliant kind. The yttria obtained is white, and shows unequivocal marks of fusion. It dissolves in sulphuric acid, and less readily in a solution of potash; ammonia does not act upon it. It combines with sulphur, selenium, and phosphorus.

It results from these and former experiments, that the bases of alumina, glucina and yttria, are metals which at common temperatures do not oxidize either in the air or water, but decompose it when acids are present; and combine, and almost always with extraordinary heat, with oxygen, chlorine, bromine, iodine, sulphur, and selenium.—*Ann. de Chim. et de Phys.* xxxix. 77.

ACTION OF SULPHURETTED HYDROGEN ON SOLUTIONS OF MERCURY.

M. Rose remarks that it is well known if, sulphuretted hydrogen be passed into a solution of mercury, that a white precipitate is at first formed, which eventually becomes black sulphuret. The white

precipitate obtained from permuriate of mercury in excess, is formed of

Mercury	81·80
Chlorine	9·53
Sulphur	8·67
	100·00

M. Rose remarks, that these proportions are equivalent to 1 atom of chloride of mercury and 2 atoms of sulphuret of mercury; but they are not reducible to this composition, employing the numbers generally adopted in this country.

This compound, prepared by passing sulphuretted hydrogen into a solution of permuriate of mercury, remains long suspended, and forms an emulsion, which filters with great difficulty. It is better to boil black sulphuret of mercury, while moist, with permuriate of mercury; but it must be left for some time that it may filter readily. The white precipitate dries perfectly well; when exposed in a tube to heat, it is decomposed, and perchloride of mercury is sublimed; the sulphuret of mercury is volatilized rather later. That the separation of these substances may be perfect, it is necessary not to heat them too quickly; the white precipitate is insoluble even in concentrated acid, but is rapidly acted upon by aqua regia: when heated in a tube and exposed to chlorine, chloride of sulphur is first obtained, and afterwards perchloride of mercury. Caustic alkalies gradually blacken it; even in the state of carbonates an alkaline chloride is formed, and the oxygen of the alkali takes the place of the chlorine; but the oxide of mercury remains in the state of mixture with the sulphuret.

Analogous phænomena occur with the perbromide, periodide, and perfluoride of mercury: the compound bromide and sulphuret of mercury was obtained by digesting sulphuret of mercury in a solution of perbromide; it is of a yellowish white colour: by heat it is decomposed into bromide of mercury, which volatilizes first, and sulphuret of mercury, which sublimes afterwards: it is composed of 1 atom of perbromide, and 2 atoms of sulphuret of mercury.

Periodide of mercury treated with sulphuretted hydrogen gives a yellow precipitate, which remains suspended, and is easily separated from the iodide in excess; by heat it is decomposed into periodide and sulphuret of mercury.

Perfluoride of mercury similarly treated offers analogous results: by treating a solution of peroxide of mercury with excess of fluoric acid, a white precipitate is obtained, which when washed and dried so as to deprive it of all water, becomes yellowish, which colour it loses on regaining water: it is decomposed by boiling water.

The solutions of mercury in all acids give precipitates with sulphuretted hydrogen, which contain a portion of the solvent acid; the only one analysed was obtained from pernitrate of mercury. It consisted of

Sulphuret of mercury	58·95
Pernitrate of ditto	41·05
	100·00—*Ibid.* xl. 46.

SALTS

SALTS OF RHODIUM AND OXIDES OF PALLADIUM.

The following analyses are from a paper by Berzelius, contained in the *Annales de Chimie et de Physique.* The results of his analyses, simply are given without his views of their atomic constitution.

Chloride of Sodium and Rhodium:

Chloride of Sodium.....	45·55
Chlorine	27·48
Rhodium.....	26·97
	100·00

Hydrate of Rhodium:

Rhodium.....	75·9
Oxygen	17·5
Water	6·6
	100·0

Protoxide of Palladium:

Palladium.....	86·94
Oxygen	13·06
	100·00

Peroxide of Palladium:

Palladium	76·92
Oxygen	23·08
	100·00

HYPOSULPHURIC ACID AND HYPOSULPHATES.

Dr. Heeren forms the hyposulphuric acid nearly in the mode described by MM. Gay-Lussac and Welter, excepting that he separates the oxide of manganese by sulphuret of barium instead of barytes water. The excess of sulphuret of barium is separated by carbonic acid, heating and filtering: the solution, when sufficiently concentrated and cool, gives perfectly pure crystals of hyposulphate of barytes; these decomposed by sulphuric acid yield free hyposulphuric acid.

Hyposulphate of potash was prepared by decomposing a hot solution of hyposulphate of lime by carbonate of potash. The crystals are fine, and resemble those of sulphate of potash. One part of this salt is soluble in 1·58 of boiling water, and 26·5 at 60° Fahr. It is insoluble in alcohol, has a bitter taste, contains no water of crystallization, and is neither efflorescent nor deliquescent.

Hyposulphate of soda is in large fine clear quadrangular prisms; they are unalterable in the air, and contain 15·54 per cent of water: this salt is soluble in 1·1 part of water at 212°, and 2·1 at the temperature of 60°. It is insoluble in alcohol: its taste peculiar and bitter.

Hyposulphate of ammonia is obtained by decomposing hyposulphate of barytes with sulphate of ammonia: it crystallizes with difficulty, and the crystals are too small to permit their form to be determined. It is soluble in less than its own weight of water, and insoluble in alcohol. Its taste is cooling, like that of sulphate of soda; suffers no alteration by exposure to the air; but when the temperature is

raised, it loses its water without fusing; it then evolves sulphurous acid and part of its ammonia: the fused residue has an acid re-action. It contains 18·44 per cent of water.

Hyposulphate of barytes requires 1·1 part of water at 212°, and 4·04 parts at 65° for solution. It is insoluble in alcohol, its taste is bitter and astringent, unalterable in the air; decrepitates strongly when heated. M. Heeren remarks that this salt crystallizes in two different forms, which cannot be reduced to the same primary form, although the composition is evidently the same. It contains 10·78 per cent of water. By spontaneous evaporation it is obtained in oblique quadrangular prisms, terminated by four facets. Exposed to the air they effloresce and become opaque without losing their form: they may be kept for a long time in moist vessels: they contain 19·48 per cent of water, half of which they lose by efflorescence, and are converted into the preceding salt.

Hyposulphate of strontia is obtained in the same manner as the barytic salt. It is soluble in 1·5 part of water at 212°, and 4·5 parts at 60° insoluble in alcohol, unalterable in the air, and bitter. It crystallizes in large hexagonal tables, the edges of which are bevelled. It contains 22·10 per cent of water.

Hyposulphate of lime is obtained in the same way as the preceding, the crystals of which it strongly resembles. It contains 26·24 per cent of water, and requires 0·8 of water at 212°, and 2·46 at 67°, for solution. Although insoluble in alcohol, it appears to yield part of its water to it. Is taste is purely bitter.

Hyposulphate of magnesia was obtained by decomposing the sulphate with hyposulphate of barytes. It crystallizes in hexhedral prisms, which are unalterable in the air: these crystals fuse in their water of crystallization at a high temperature. For solution they require 0·88 parts of water at 64°; they contain 37·69 per cent of water of crystallization.

Hyposulphate of alumina is procured by adding a solution of hyposulphate of barytes to one of sulphate of alumina. The solution was concentrated by a gentle heat, and dried in a vacuum over sulphuric acid. The salt procured precipitated muriate of barytes; it appears, therefore, that this salt cannot exist when deprived of water. By spontaneous evaporation it is obtained in very small crystals.

Protocarbonate of cerium was dissolved in hyposulphuric acid: by spontaneous evaporation small colourless unalterable crystals of protohyposulphate were formed.

Protohyposulphate of iron crystallizes in oblique quadrangular prisms, which acquire oxygen gradually by exposure to the air; but they are neither deliquescent nor efflorescent: they are readily soluble in water, insoluble in alcohol, and have the taste and colour of protosulphate of iron; they contain 30·04 per cent of water. This salt is obtained by adding protosulphate of iron to hyposulphate of barytes; and hyposulphate of zinc is similarly obtained: the crystals are unalterable by exposure to the air, very soluble in water, and contain 32·24 per cent of it;—their form could not be ascertained; their taste is astringent.

Hydrosulphuric

Hyposulphuric acid dissolves carbonate of cadmium: the salt formed is crystallizable, very soluble and deliquescent; its taste is astringent; it contains water of crystallization, the quantity not determined.

Hyposulphuric acid forms three compounds with lead. The neutral salt is obtained by treating carbonate of lead with hyposulphuric acid. It is very soluble, has a very sweet taste, but rather astringent. Its crystals resemble those of hyposulphate of lime and strontia. It contains 15·95 per cent of water. When into a solution of this salt ammonia is poured, in less quantity than required to precipitate the whole of the lead, very small crystals of a subsalt are deposited, which are but slightly soluble in water: these when treated with excess of ammonia are converted into a fine powder, which is still more insoluble. By exposure to the air they both absorb carbonic acid: the first appears to be a compound of one atom acid, two atoms oxide, and two of water; the second of one atom acid, ten atoms oxide, and twenty-five of water.

Hyposulphate of copper, prepared in the same way as that of iron, is readily soluble in water, but insoluble in alcohol. When heated it decrepitates, and by exposure to the air effloresces. It has usually the form of quadrangular prisms; it contains 25·47 per cent of water. When the solution is treated with a small quantity of ammonia, a blueish green subsalt is separated; this does not acquire carbonic acid by exposure to the air: when heated, its colour becomes first green, and then ochrey; after calcination, it dissolves with a blue colour in muriatic, nitric, and sulphuric acids, and also in ammonia. It is no longer soluble in water, but combines with altering its colour to blue, if the water is cold, and greenish blue, if hot.

Hyposulphate of cobalt is of rose-red colour, unalterable in the air, very soluble in water, and contains 32·54 per cent of it.

Hyposulphate of silver crystallizes in octagonal prisms. It is obtained by treating carbonate of silver with hyposulphuric acid. At a temperature of 6° it dissolves in two parts of water, unalterable in the air, and contains 8·95 per cent of water; this salt combines with ammonia; the compound is but slightly soluble, and readily obtained in crystals.—*Ann. de Chim. et de Phys.* Jan. 1829.

LIST OF NEW PATENTS.

To A. Daninos, of Leman-street, Goodman's Fields, for an invention, communicated from abroad, for the manufacture of improved hats and bonnets in imitation of Leghorn straw hats and bonnets. —Dated the 5th of February, 1829.—6 months allowed to enroll specification.

To J. Burgis, of Maiden-lane, Covent Garden, for a method of gilding woven fabrics in burnished and dead or matted gold or silver, and which fabrics may be used as gold or silver and laced borderings, &c.—5th of February.—2 months.

To R. Green, of Blackwall, for improvements in the construction of masts.—5th of February.—4 months.

To W. H. Kitchen, of High-street, St. Giles's, Bloomsbury, and A. Smith,

A. Smith, of York-terrace, Westminster, for improvements in the construction of window-frames, sashes or casements, shutters and doors, designed to afford security against burglars, as well as to exclude the weather.—7th of February.—6 months.

To E. Head, of Devonshire-street, Vauxhall Road, for improvements in illumination, or producing artificial light.—12th of February.—6 months.

To S. Walker, of Beeston, Leeds, cloth manufacturer, for an improved apparatus, which he denominates "an operameter," applicable to machinery for dressing woollen or other cloths.—20th of February.—6 months.

To W. Church, esquire, of Bordesley Green, in the parish of Aston, Warwickshire, for improvements in buttons, and in the machinery for manufacturing the same.—26th of March.—6 months.

To W. Madeley, of Yardley, Worcestershire, farmer, for an apparatus for catching, detecting, and detaining depredators and trespassers, or any animal, which he denominates "the humane snare."—28th of March.—2 months.

METEOROLOGICAL OBSERVATIONS FOR MARCH 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·24 March 3. Wind N.E.—Min. 29·16 March 30. Wind S.E.
Range of the index 1·08.

Mean barometrical pressure for the month	29·763
Spaces described by the rising and falling of the mercury.....	4·280

Greatest variation in 24 hours 0·420.—Number of changes 17.
Therm. Max. 60° on three different days.—Min. 30° March 14. Wind N.
Range 30°.—Mean temp. of exter. air 44°·47. For 30 days with ☉ in ♓ 43·97
Max. var. in 24 hours 22°·00—Mean temp. of spring water at 8 A.M. 50°·00

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the evening of the 20th ...	85°
Greatest dryness of the atmosphere in the afternoon of the 14th	43
Range of the index.....	42
Mean at 2 P.M. 56°·4—Mean at 8 A.M. 69°·4—Mean at 8 P.M.	65·5
—— of three observations each day at 8, 2, and 8 o'clock.....	63·8

Evaporation for the month 1·70 inch.
Rain in the pluviameter near the ground 0·94 inch.
Prevailing wind, N.E.

Summary of the Weather.

A clear sky, 4; fine, with various modifications of clouds, 9½; an overcast sky without rain, 13½; rain, 4.—Total 31 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
13	3	30	1	12	22	12

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
1	14	7	5	1	1½	½	1	31

General

General Observations.—The first part of this month was cold and dry, and the latter part mostly fine, with seasonable intervening showers. The wind having prevailed two-thirds of the period from the N.E. and E., the frosts were felt rather keen in the early part of the mornings; so that the spring was scarcely perceptible till the vernal equinox, on which day, as well as on the 22nd and 29th, the thermometer rose to 60 degrees in the shade. Even in the first week of the month the dust in the roads had very much increased in consequence of the dryness of the N.E. wind, which in March prevails much longer in proportion than in any other month. A more favourable seed-time and for other agricultural purposes could not have happened. The last three winter months have been seasonable and dry, and only three and a quarter inches of rain have fallen here since the end of last December.

In the mornings of the 1st, 15th, 16th, and 25th, the ice on the ground was more than one-third of an inch thick.

In the evening of the 12th a large lunar halo appeared, and measured in perpendicular diameter 45 degrees; it was soon followed by light rain and snow, the latter slightly covered Portsdown Hill the following morning.

The whole of the mornings of the 22nd and 28th, coloured solar halos appeared in beds of *cirrostratus;* their horizontal diameters measured respectively 45° 15′, and they were also succeeded by rainy nights.

The mean temperature of the external air this month is nearly three quarters of a degree *under* the mean of March for the last thirteen years; but this will be advantageous in the end, if the spring should not be unusually cold and wet, which, from a consideration of the high temperature of the ground, and the times that the lunar phases will happen, are circumstances not very likely to occur.

The temperature of spring water has not varied the whole of the month.

The atmospheric and meteoric phænomena that have come within our observations this month, are one lunar and two solar halos, two meteors, and four gales of wind from the North-east.

REMARKS.

London.—March 1. Clear and cold. 2, 3. Cloudy. 4. Stormy. 5—7. Fine. 8. Cloudy: heavy shower of sleet in the afternoon. 9. Cloudy. 10. Very fine: slight fog at night. 11. Cloudy. 12. Fine. 13, 14. Cloudy. 15. Fine. 16. Clear and cold. 17—19. Very fine. 20. Cloudy morning: fine: heavy gale of wind at night. 21—25. Fine. 26. Cloudy. 27. Very fine. 28. Fine: heavy rain at night. 29. Wet morning: cloudy. 30, 31. Cloudy.

Boston.—March 1. Fine. 2. Snow. 3—9. Cloudy. 10. Fine. 11—13. Cloudy. 14. Cloudy: snow A.M. 15—19. Fine. 20. Stormy. 21, 22. Fine. 23, 24. Cloudy. 25. Fine. 26. Cloudy. 27. Fine. 28, 29. Cloudy. 30. Cloudy: rain A.M. 31. Cloudy.

☞ This month has produced less rain than any month for the last five years.

Penzance.—March 1. Clear. 2—5. Fair. 6. Fair: clear. 7. Fair. 8—10. Fair: clear. 11. Fair. 12. Clear: rain. 13. Fair. 14. Fair: clear. 15, 16. Fair. 17. Fair: showers. 18, 19. Rain. 20. Showers: fair. 21. Fair. 22. Rain. 23. Misty: fair. 24. Fair. 25, 26. Clear. 27. Fair. 28. Fair: rain. 29. Rain: clear. 30. Clear. 31. Fair.

Meteoro-

Meteorological Observations made by Mr. BOOTH at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month. 1829.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond.	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.									
March 1	30·264	30·173	30·00	30·00	30·10	30·04	29·95	36	30	43	39	40	34	34	E.	SE.	NE.	calm	…	…	…	…	…
2	30·361	30·203	30·20	30·10	30·18	30·08	29·95	36	32	40	34	39	36	35	E.	E.	NE.	calm	0·10	…	…	…	…
3	30·403	30·353	30·28	30·28	30·24	30·24	30·03	41	34	44	36	42	39	36	E.	E.	NE.	calm	…	…	…	0·020	…
4	30·250	30·184	30·25	30·20	30·10	30·06	29·90	44	31	45	34	47	35	40·5	NE.	E.	NE.	calm	…	…	…	…	…
● 5	30·249	30·168	30·15	30·10	30·10	30·06	29·90	45	35	43	35	45	38	37·5	E.	E.	E.	calm	·15	…	…	…	…
6	30·132	30·044	30·05	30·00	30·00	29·95	29·77	46	37	46	36	48	39	41	E.	E.	E.	calm	…	…	…	…	…
7	30·026	30·014	29·98	29·98	29·93	29·90	29·67	47	39	46	40	48	42	41·5	NE.	E.	NE.	calm	…	·02	…	…	…
8	30·009	29·999	30·00	29·98	29·92	29·91	29·63	47	38	48	40	52	42	41	NE.	E.	NE.	calm	·15	…	…	…	…
9	29·939	29·872	30·00	29·98	29·84	29·80	29·47	51	35	50	40	54	43	43	NW.	SE.	N.	calm	…	…	…	…	…
10	29·900	29·894	29·90	29·80	29·80	29·80	29·46	48	30	50	39	53	35	39	NE.	SE.	SE.	N.	…	…	…	…	…
11	29·869	29·834	29·78	29·75	29·76	29·74	29·51	44	30	45	40	46	36	40	SE.	E.	NE.	calm	…	…	…	…	…
☽ 12	29·818	29·708	29·70	29·50	29·66	29·59	29·45	43	34	47	40	47	39	39	E.	SE.	NE.	calm	·10	…	0·210	·060	…
13	29·867	29·695	29·75	29·50	29·70	29·56	29·38	43	32	45	41	47	37	39	NE.	SE.	NE.	calm	…	…	…	…	…
14	29·968	29·916	30·00	29·96	29·86	29·83	29·50	42	21	45	37	46	30	34	E.	E.	N.	calm	…	…	…	…	…
15	29·976	29·929	30·00	29·90	29·85	29·80	29·62	42	22	45	37	44	30	32·5	NE.	SE.	N.	NW.	·15	…	…	…	·03
16	29·839	29·616	29·75	29·65	29·70	29·54	29·54	45	25	44	37	45	32	34	E.	SE.	E.	NW.	…	…	…	…	…
17	29·642	29·533	29·65	29·55	29·54	29·45	29·16	50	28	51	36	54	36	34	SW.	SW.	SW.	NW.	…	…	…	·010	…
18	29·761	29·733	29·55	29·50	29·65	29·64	29·35	56	41	50	39	57	43	38·5	SW.	SW.	SE.	NW.	·15	…	·210	·120	…
19	29·690	29·553	29·45	29·25	29·54	29·45	29·26	57	40	52	49	57	48	49·5	W.	S.	SE.	W.	…	…	·140	·010	…
○ 20	29·985	29·666	29·85	29·65	29·87	29·66	29·07	60	42	54	47	60	48	54	SW.	W.	SW.	W.	…	…	·050	·140	…
21	30·133	29·992	30·00	29·98	30·00	29·98	29·61	58	35	53	44	56	42	47	SE.	SE.	SE.	NE.	·30	…	…	…	…
22	29·912	29·803	29·75	29·73	29·76	29·68	29·50	56	42	52	47	60	46	43	SE.	SE.	E.	calm	…	…	·410	·160	…
23	29·965	29·836	29·70	29·68	29·80	29·69	29·53	52	36	54	47	48	39	41	E.	SE.	NE.	E.	…	…	…	·060	…
24	29·955	29·913	29·68	29·66	29·78	29·77	29·55	46	22	48	45	51	31	38·5	E.	SE.	E.	E.	·20	…	…	…	…
25	29·991	29·959	29·90	29·80	29·87	29·85	29·62	49	26	48	42	50	37	37	E.	SE.	NE.	NW.	…	…	…	…	…
26	30·028	30·007	29·90	29·88	29·92	29·90	29·60	49	37	48	40	48	41	42·5	E.	SE.	SE.	N.	…	…	…	…	…
27	29·989	29·860	29·78	29·74	29·86	29·74	29·55	51	30	52	43	48	38	42	E.	SE.	E.	calm	·20	…	…	…	…
☾ 28	29·698	29·462	29·50	29·45	29·56	29·38	29·33	55	39	51	44	55	44	42·5	NE.	SE.	E.	calm	…	…	·68	·200	·150	…
29	29·345	29·331	29·40	29·38	29·29	29·27	28·96	47	39	56	44	60	45	43·5	N.	SW.	W.	E.	…	…	·160	·030	…
30	29·276	29·250	29·22	29·20	29·20	29·16	28·90	48	38	50	46	55	41	42	N.	SE.	E.	calm	…	…	·085	·100	·12
31	29·380	29·266	29·45	29·35	29·22	29·16	28·91	43	33	48	45	51	38	41	NE.	SE.	NE.	calm	·20	·05	…	·080	·02
Aver.:	30·403	29·250	30·28	29·20	30·24	29·16	29·50	60	21	56	34	60	30	40					1·70	0·75	1·465	0·940	0·17

Fig: 1.

E.S.E.

SECTION from the PLAINS of VENICE below AZOLO to the ALPS above POSSAGNO in a N.N.W. direction.

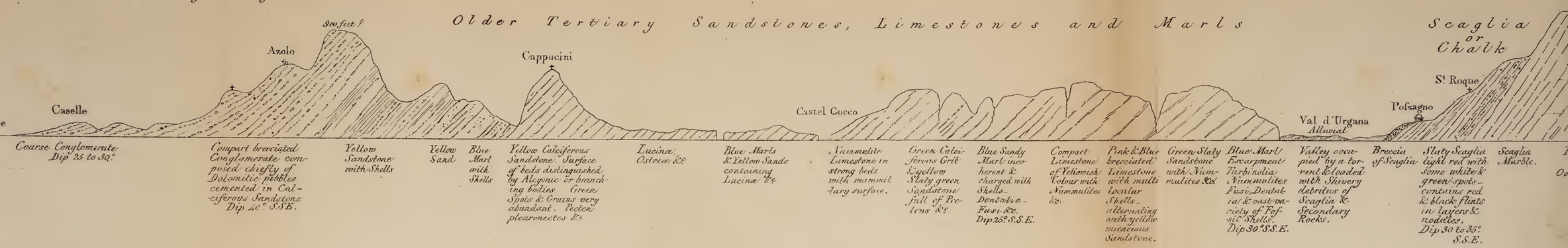
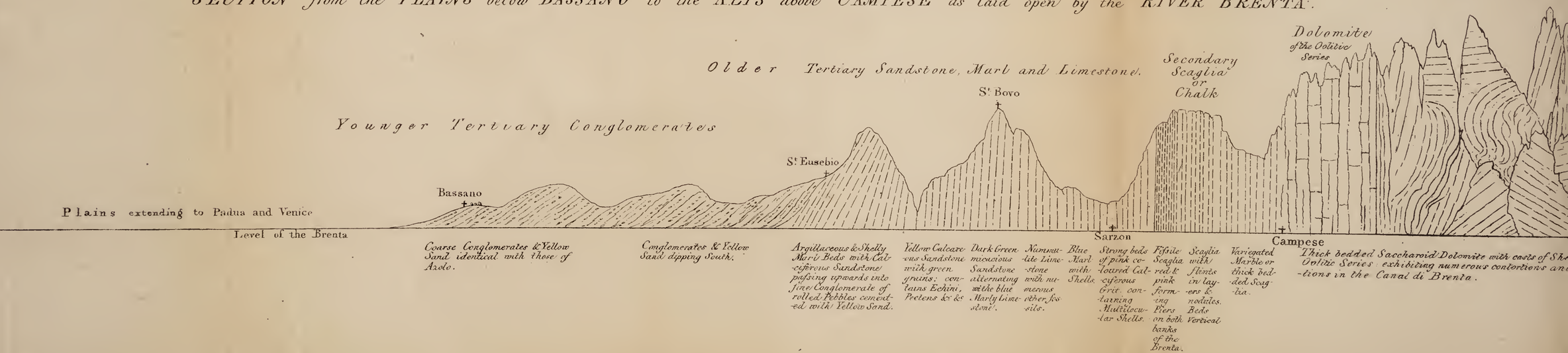


Fig: 2.

S.S.E

SECTION from the PLAINS below BASSANO to the ALPS above CAMPESE as laid open by the RIVER BRENTA.



THE

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[NEW SERIES.]

JUNE 1829.

LIX. *On the Relations of the Tertiary and Secondary Rocks forming the Southern Flanks of the Tyrolese Alps near Bassano.* By Roderick Impey Murchison, *F.R.S. Sec. G.S. F.L.S. &c. &c.**

[With a Plate.]

THAT various members of the secondary deposits replete with marine remains are found in dislocated positions in some of the highest regions of the Alps, was long ago noticed by De Saussure; and the fact has since been confirmed by many other geologists. The inference derived therefrom, that such remnants can alone have been placed at these heights by elevation from beneath the sea, is now considered by the greater number of observers to be the only philosophical mode of explaining the phænomenon. The object of this memoir is to determine whether the same causes of elevation were applied at a subsequent period to those newer or tertiary deposits which now form a belt around the flanks of the Alps. The solution of this question is called for, because the evidence on this point has hitherto remained so imperfect, that several naturalists are still disposed to adhere to the old opinion, that the forces which gave to the secondary rocks their actual configuration, had entirely ceased to act before the deposition of the tertiary strata. The following sections, which I made last autumn on the southern flank of the Alps near Bassano, appearing to throw light on this curious and important point, no apology is requisite for presenting them to the consideration of geologists; indeed, any details of the structure of distant groups of the tertiary deposits must be considered of high interest when it is stated, that on the sides of the Alps and

* Read before the Geological Society, March 1829; and communicated by the Author.

Apennines they fully rival in thickness our most important secondary formations in England. This particular group, however, near Bassano, is not offered as a type of all the other tertiary deposits of the north of Italy, where their variable characters may still form the subject of other communications from Mr. Lyell and myself.

The tertiary or subalpine deposits, which to the west of the Brenta are so much traversed by basaltic and trap rocks, are entirely free from them in this district between the rivers Brenta and Piave, where they swell into hills of considerable importance, occupying between Asolo and Possagno a breadth of four or five miles. Here, as in many other parts of the north of Italy, they form two great natural divisions :—

1st. An exterior zone composed of conglomerates, with subordinate beds of yellow sand and blue marl, containing shells, the greater number of which are found in the subapennine formations described by Brocchi, and amongst which a considerable proportion of the species are identical with those of the present sea*.

2ndly. An inferior system of green and yellow calcareous sandstone, blue shell marl and compact limestone, some of which are distinguished by nummulites. These latter beds rest upon the scaglia (or equivalent of the chalk), which rising into the Alps passes into a dolomitic limestone of the oolitic series.

Explanatory of these relations, I now proceed to detail two sections in a descending order: the first from Asolo† to Possagno at the foot of the Alps ; the second from Bassano to Campese at the mouth of the Canal di Brenta, where that river issues from the Tyrol.

I. The tertiary conglomerates rise from the plains of Venice, about a mile and a half south of Asolo, at an angle of about 20° to 25°, dip S.S.E.; and to the north of that place they reach to the height of at least seven hundred to eight hundred feet above the level of the Adriatic. The angle of their inclination increases with their altitude; and the mountain torrents flowing from north to south, expose many of these beds dipping even as high as 40° S.S.E.

The boulders contained in these rocks are of very great size

* This zone is the equivalent of the subalpine conglomerates and marls near Nice, which Mr. Risso was the first to identify with the subapennine formations of Brocchi.

† Fortis in his "Mémoires," vol. i. p. 144, gives a slight sketch of the district of Asolo, but without any attempt to explain its geological relations. He however describes "Madrepora fungites" in blue marl at Castel Cucco; Turbinites terebra and editus of Brander, fig. 47; Dentalium, Murex of ditto; Helix mutabilis, Brander, fig. 58; and other shells in the Val d'Urgana. His figures of the Madrepora fungites are very characteristic.—P.147.

towards

towards the exterior of the zone, but they become smaller in the lower beds: some of these boulders are of primary rock, but by far the greater number are referrible to the dolomite of the neighbouring Alps; in the higher beds these are packed together with little or no cementing matter, whilst in the lower they are frequently imbedded in a hard yellow calcareous sandstone forming a compact breccia: still lower there are beds of incoherent yellow sand with some organic remains; and this system may be said to terminate in the escarpments north of Asolo, where a fine conglomerate is seen alternating with beds of blue marl and yellow sand, both containing shells. In the descending series there is no repetition of conglomerates, and the upper system has therefore a well marked termination*. (Plate V. Section, fig. 1.)

The lower system is ushered in by a chain of conical hills, the highest beds of which consist of a thick-bedded yellow sandstone charged with green grains, alternating with strong beds of calciferous grits, and dipping under the conglomerates at angles varying from 25° to 30° S.S.E. These contain many organic remains; amongst which are Pectunculi, Pectens, Echini, &c. The surfaces of the beds are further remarkable for the vast quantity of branching stem-shaped bodies resembling Alcyonia. At the base of the escarpment of these hills there is a considerable thickness of blue marl, which is prolonged for about a mile to the north, forming low undulations, the beds of which are exposed on the banks of several streamlets running from west to east. The characteristic shells of this marl seemed to be Lucina concentrica (Venus concentrica, *Brocchi*), Lucina mutabilis (Venus mutabilis, *Lamarck*), Echini, &c. North of the small river at Castel Cucco, a compact limestone rises from beneath the marls and attains considerable elevation. The upper beds have a mamillary surface, but upon fracture are of a solid madreporic structure and bluish colour: below this are strong beds of green slaty calcareous grits and yellow sandstone, the latter containing many Pectens, &c.

Succeeding to the above there is a repetition of blue sandy incoherent marls, some beds of which are entirely occupied by vast quantities of a Turritella highly resembling if not identical with the T. sinuosa of Bourdeaux; whilst others are filled with the following shells: Natica glaucinoides of the London

* In this respect the order of the strata does not coincide with that which Mr. Lyell and myself observed in the valleys of the Bormida, or at the Superga near Turin, where powerful conglomerates reappear very low in the tertiary series, beneath an enormous development of green slaty micaceous sandstone and shale.

clay; Solarium approaching to S. canaliculatum, but somewhat differing from the Bourdeaux species; Chama squamosa. Of the London clay, small ostrea, Dentalium grande, &c. &c.

Then follows a yellowish compact limestone with green grains, in strong beds, distinguished by nummulites, oval amygdaloidal concretions of green earth, and alternating layers of blue marl. The limestone succeeding to this has a semi-brecciated fracture, with a pink and bluish tinge*, and is charged with nummulites, &c., the whole alternating with yellow-green micaceous sandstones. The latter repose upon and pass into a calciferous grit containing lenticulites, operculines, cyclolites, and other small multilocular shells, characteristic of the inferior tertiary formations in the north of Italy†.

The escarpment of the lowest part of the tertiary deposits exposed in this section is composed of blue marl, the beds of which have precisely the same S.S.E. dip as the series of nummulite limestone, green sandstone, and conglomerate, previously described; and in a hasty examination the following corals and shells were collected at this spot:—

Caryophyllia altavillensis; Fungites (figured by Fortis, *Mémoires*, vol. i. p. 147.); Lenticulites complanata (Operculine of D'Orbigny); Orbitulite (two species); Cyclolites cristata; 1. Nummulites planulata; 2. Nummulites variolaria; Conus stromboides (C. concinnus of *Min. Conch.*); Pleurotoma undata; Fusus longævus; Voluta harpula; Cassis diadema; Serpula spirulæa.

The Alps rise at a rapid angle about half a mile north of the above escarpment; the intermediate low space called the Val d'Urgana, in which flow several torrents from west to east, emptying themselves into the Piave, is choked up with the shivery detritus of the impending secondary rocks, and therefore no junction between the latter and the tertiary is observable. (Section, fig. 1.) Possagno, ornamented by the magnificent new Temple of Canova, stands upon the first ledges of the scaglia, which rock here rises into the Alps. The upper beds are of a red colour, with some white and green blotches, are very slaty, occasionally contain layers of flint, dip S.S.E. 30° to 35°, and pass downwards into more com-

* It is in this range of limestone that quarries have recently been opened at Costa lunga, from which have been extracted the principal columns of Canova's splendid new Temple at Possagno. It is a mottled marble, very ornamental, and takes a high polish. Futurity may decide whether this tertiary rock of Europe shall prove as durable a building-stone as that of a similar epoch with which the pyramids of Egypt were constructed.

† In this range of hills lignite is found, which on the authority of Brocchi is imbedded in the blue marl with marine shells.—*Conch. Subap.* vol. i. p. 97.

pact

pact and thick beds, from which variegated marbles are extracted. During my short examination I could detect no organic remains in the scaglia of this district; in which respect, as well as in mineralogical structure, it seemed to be quite identical with the calcareous rock of the Euganean Hills*.

A perfect conformity of dip and bearing of the tertiary to the secondary or ammonite deposits is exhibited in the preceding section; but their junction, as has been stated, is obscured by the denudation in the valley of Urgana, and all along the base of the Alps between Possagno and Bassano it is concealed by vast accumulations of alluvial detritus.

II. The river Brenta, however, in issuing from the Tyrol, cuts transversely through all the deposits from the oolitic series to the most recent, and exposes a most unequivocal junction between the secondary and tertiary rocks, which has not yet, as far as I am aware, been noticed by any geologist. I will describe this section like the former in a descending order. (See Section, fig. 2.)

The youngest beds at Bassano consist of conglomerates, with subordinate and irregular layers of yellow sand, the whole dipping gently away to the plain from the low hillocks on which that town is situated. A little above the bridge the conglomerate forms cliffs on both banks of the river, from fifteen to twenty feet in height, dipping 20° to 25° S.S.E. Ascending the Brenta, and thus approaching the Alps, the lower beds of conglomerate become more highly inclined; and thinning out as at Asolo, they finally pass into yellow sandstone and calciferous grit. The sandstone is micaceous, contains in certain parts many green grains, and hydrate of iron, and the characteristic fossils were Pectens, and other bivalve shells, with Echini, &c. After this the inclination of the strata increases rapidly; and previous to reaching the village of St. Eusebio, the dip already amounts to 40° S.S.E. Green sandstone and blue marl succeed to the above; the surfaces of the more indurated beds being dotted with nummulites, and the marls full of shells similar to those described between Castel Cucco and Possagno. These are most instructively exhibited on the right bank near the village of Sarzon, where the stony beds having gradually increased their inclination to angles from 70° to 80°, run out like so many walls into the channel of the Brenta; whilst some of the intermediate marls being

* I am informed by the Marchese Parolini, that in other parts of this neighbourhood the same rock does contain ammonites, belemnites, &c.: for this we have also the authority of Fortis, Maraschini, Professor Catullo, and Dr. Pollini, so that the scaglia may be considered the equivalent of the chalk, a place already assigned to it by Prof. Buckland.

washed

washed out, the fossilist is enabled, when the river is low, to collect the remains of each layer by inclosing himself between the projecting beds of stone, the upper and lower surfaces of which are thus placed on either side of him. The perfect state of preservation of the shells in these vertical beds is a distinct proof that the dislocation of strata, even when vertical, does not, as some geologists have imagined, necessarily produce any derangement or destruction of their organic contents. These strata mount into a steep hill, on the summit of which is the little church of St. Bovo, at least from six to seven hundred feet above the river, and where they form an outline nearly as peaked and grotesque as that of the adjoining dolomite, or of any other crystalline rocks; thus showing that external form may be entirely due to the inclination of the beds, without any reference to the structure or age of the rock. After passing along the edges of a considerable thickness of blue marly strata, much of which has been swept away by the river, there occurs a very compact brown and pink-coloured limestone, containing small multilocular shells and nummulites. This limestone is the lowest of the members of the tertiary series, and the beds having now become absolutely vertical, are seen in contact with the red scaglia with flints or representative of the chalk, without the slightest appearance of unconformable deposition, the edges of the two formations having a parallel direction from W. to E., as seen in the vertical piers on both sides of the river, on the west bank of which they rise together into a lofty hill. (See Section, fig. 2.)

The upper beds of the scaglia are red and fissile, precisely like those described at Possagno, with flints both in layers and in nodules, and few or no organic remains. The lower beds are thicker and more compact, and gradually losing the red colour, they pass into a beautiful white saccharoid marble, a variety of which is largely quarried (and called Biancon di Pove)*. The vertical edges of this rock are seen for several hundred feet along the right bank of the Brenta; when near Campese it seems to pass into a dolomitic limestone, the beds of which are also vertical and conformable to

* Maraschini in his "*Saggio Geologico del Vicentino*" is inclined to consider the scaglia a tertiary formation, chiefly because in the districts he examined, it is unconformable to the inferior or Jura limestone. This author's sections, however, were all made in the country west of the Brenta, where the deposits being traversed by a variety of trap rocks, cannot be selected as proofs that the unconformability of the strata is due to any other than a partial cause; for in the district I now describe, and where igneous rocks have *not* penetrated, it has been shown that all the deposits are perfectly *conformable*. But in some of the adjoining regions to the west, and even when intermixed with volcanic rocks, the same deposits are again strictly conformable;

to those of the scaglia. Further in the interior this dolomite rises into peaks of great height; and for a full knowledge of its mineral characters I refer to the works of Von Buch (*Annales de Chimie*, vol. xxiii.), it being sufficient for my present purpose to state that unlike the older and metalliferous dolomite, which I have described in a notice upon Seefeld near Innspruck*, the rock of this neighbourhood is charged with numerous and very perfect casts of shells of the oolitic series†; whilst in the western parts of the same chain the rock is a true oolitic limestone. In ascending the Canal di Brenta to the source of that river, I found this dolomite occupying the whole region, forming lofty cliffs on both banks, and distinguished by innumerable contortions of its beds, which are inclined at every angle from horizontal to vertical. (See Section, fig. 2.)

Conclusion.—The perfect conformability of the secondary and tertiary strata shown in the preceding sections, whether their mutual angle of inclination be from 30° to 35° as at Possagno, or vertical as in the Canal di Brenta, prove that these several deposits have here partaken simultaneously of some of those great convulsions by which the older rocks of the Tyrolese Alps on which they rest, have been elevated; and the evidence is such, that certain geologists cannot in this instance admit the elevation of the secondary rocks or those containing ammonites, belemnites, &c., and at the same time reject the application of similar disturbing causes to the more recent tertiary deposits; for we see not only the oldest tertiary limestones and marls, but also the most recent conglomerates, rising at very rapid angles to considerable heights.

There is yet much to be learned respecting the order of superposition of the various members of the tertiary formations

conformable; and for a full account of these interesting phænomena N. of Verona, I refer the reader to a most able memoir of Dr. Ciro Pollini, "*Lettera Geologica sui Monti Veronesi.*" (Biblioteca Italiana, vol. xxviii.) Dr. Pollini shows that the Calcaire grossier of Verona rises on the N. of that town to upwards of 3000 feet above the Adriatic; and in its lowest beds passes into, and even alternates with the scaglia or ammonite rock, which in its turn graduates (particularly at the Ponte di Veja) into a subjacent limestone made up of oolitic particles, and charged with fossils of the oolitic series. From these observations Dr. Pollini concludes, that the division of strata into secondary and tertiary formations is merely systematic, and not founded on any natural distinctions; and hence he adopts a new nomenclature of Ultima calcare (Calcaire grossier), Penultima calcare (chalk), Terzultima calcare (oolite). Dr. Pollini, it should further be remarked, states that N. of Verona, nummulites do not cease with the Calcaire grossier in a descending series, but that they occur abundantly in the scaglia, and even as low down as the oolite of the Jura limestone.

* Read before the Geological Society, March 1829.

† Marchese Parolini has a fine collection of these organic remains in his instructive cabinet at Bassano.

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in different parts of the north of Italy. Brocchi having described the whole of these deposits under the head of Subapennine*; and thus formations of the age of our London clay being confounded with those blue marls containing a variety of *recent* shells, it now becomes quite essential to state that the inferior members are essentially different from the superior in zoological contents; it being in the upper beds only that we find a large proportion of shells of the present sea. To this latter epoch belong the conglomerate sands and marls of Asolo and Bassano; and the strata which succeed, offer (amidst the few specimens which my hurried examination permitted me to collect), some species resembling those of the Bourdeaux basin; whilst by far the greater number of the shells enumerated in the oldest members of marl and limestone, near Possagno and on the Brenta, are identical in species with those of the Calcaire grossier of Paris, and the London clay. The lowest beds of this formation both in the north of Europe and in Italy are very similar in containing not only many of the same species of mollusca, but also identical species of nummulites, caryophyllia, &c. Nor can it be urged that the multilocular fossils of these inferior strata are also found in the higher tertiary deposits of Italy, for the microscopic shells of Sienna figured by Soldani differ entirely from those of the Calcaire grossier both in family and species.

Now although we may compare the nummulite rock of Bassano with the Calcaire grossier of the London and Paris basins, we cannot extend the comparison to the subjacent strata: for unlike certain parts of the Paris basin, where a formation distinguished by its freshwater and terrestrial remains is interposed between the Calcaire grossier and the chalk, the plastic clay is entirely wanting near Bassano, and there also the representative of the Calcaire grossier is in conformable apposition to the scaglia or rock containing ammonites†: so that in this portion of the earth's crust we have no trace of any interval of repose between the secondary and tertiary epochs when, as some geologists have imagined, the ocean subsided, and the land was left dry for terrestrial and fresh-water productions

* *Conchiologia Subapennina*, vol. i. p. 97.

† It may be remarked, that the plastic clay is not only absent in the north of Italy but also in most parts of England, and in some situations in France, provided that formation is to be defined as one of *fresh-water* origin. In the Isle of Wight, and at Reading, it is well known that the lowest tertiary beds are exclusively charged with marine exuviæ. If zoological evidence therefore, be considered decisive, the plastic clay cannot be viewed as a distinct and extensive formation resulting from any general cause, but rather as an accidental æstuary deposit, produced by local circumstances.

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to accumulate on its surface;—On the contrary, we here find a continuity of marine deposits or conformable passage from the rocks called tertiary to those named secondary, the only grounds of distinction between the two consisting in the different nature of their organic remains.

It has been mentioned, that to the west of the district described, volcanic rocks are intermingled with the regular deposits. I only made a short excursion in that direction, and near St. Agata and Florian I observed tertiary rocks traversed by amygdaloidal trap and the vitreous basalt of Monte Gloso. These and the contiguous regions further westward are fully described by Fortis and Maraschini, both of whom show that igneous rocks have there burst through and alternated with deposits of different ages. By these numerous vents we may therefore presume, that the expansive forces were finally elaborated, which when confined below may have elevated the neighbouring deposits. I have therefore selected these deposits as types of observation, because they are wholly exempt from the confusion usually incident to any intermixture with volcanic rocks.

List of Organic Remains observed in a cursory Examination of the Tertiary Deposits near Asolo, Possagno, Bassano, &c.

(Named by Mr. James de C. Sowerby.)	Localities in other Parts of Europe.
BIVALVES.	
Ostrea. Several species, all in the younger beds above the blue marl	—
Pecten pleuronectes and other species; chiefly in the upper sands subordinate to the conglomerates.....	Subapennines throughout Italy.
Chama squamosa. Min. Con. Intermediate blue marls.	Barton cliff, Hants.
Lucina concentrica, Lam. In the higher beds of blue marl.	Placentia, Asti, &c.
——— *mutabilis*, Deshayes. do. do.	Grignon.
UNIVALVES (chiefly in the middle and lower blue marls).	
Rostellaria sinuosa?	Bourdeaux.
Cassis diadema (of Grateloup & Basterot.)	Dax and Bourdeaux.
Conus stromboides (*concinnus* of Sower.) (See Min. Conch. t. 302. f. 2.)	Highgate, Barton, and Paris.
Fusus longævus. Min. Conch. t. 63.	Lowest beds of Calcaire grossier, London clay, &c.

Univalves (*continued*).	Localities in other Parts of Europe.
Melania costellata, Lam.	Paris basin.
Mitra scrobiculata, (*Voluta scrobiculata* of Brocchi)	Placentia, Sienna, Turin.
Natica glaucinoides. Min. Conch. T. 5.	Highgate, London clay.
——— *globulus* (*Ampullaria globulus* of Deshayes).....	Calcaire grossier.
Pleurotoma undata, Lam.	London clay.
——— new species, not yet figured.	
Solarium, approaching to *Sol. canaliculatum*, but differing essentially from the species of Bourdeaux.	
Voluta harpula, Lam.	Grignon.
Multilocular Shells (in the lowest blue marls).	
Lenticulites complanata (*Operculina complanata* of D'Orbigny)	Lowest beds of Calcaire grossier, Beauvais.
——— *variolaria*, Min. Conch.....	Stubbington, in London clay.
Nummulites planulata	Calcaire grossier.
——— *lævigata*.....	Lowest Calcaire grossier, Beauvais.
——— another species.....	——
Polypifers (in the lowest blue marl).	
Fungites, (Lamouroux).	
Orbulites; two species. *Discolites* of Fortis, (see fig. 7. K. & H. pl. II. Mémoires, vol. ii.).....	Paris basin.
Cyclolites cristata, Lamarck.	
——— another and more elliptical species.	
Caryophyllia altavillensis, (Defr.)	Normandy; Hauteville, Normandy.
Two or three other species of minute corals not identified.	
Echini.	
Serpula spirulæa, (Lamarck).	Bayonne.

LX. *On the Existence of Salts of Potash in Brine-Springs and in Rock-Salt.* *By* E. W. Brayley, *Jun.*, *A.L.S.*

WHEN Dr. Marcet commenced his chemical examination of specimens of sea-water from various parts of the globe, the results of which are given in a paper published in the Philosophical Transactions for 1819, the probability that the waters of the ocean contain *potash*, "as an ingredient brought down by rivers from the decay of land-plants," was suggested to him by Dr. Wollaston. This suggestion, as is recorded in the same paper, was verified by Dr. Wollaston himself; who thought it probable, further, that potash existed in sea-water in the state of sulphate. The last production of the former chemist, published in the Phil. Trans. for 1822, (Phil. Mag. vol. lx.) consists of some researches on the less obvious contents of sea-water; proving the existence in it of a triple sulphate of potash and magnesia, and showing also that it contains an additional proportion of potash, probably in the state of muriate.

It has not appeared, hitherto, whether any chemist, in consequence of these researches, has subjected to experiment any of the varieties of rock-salt, or of brine from salt-springs, with the view of ascertaining whether they contain potash. No indication of it is recorded to have been found, in Dr. Henry's analyses of the Cheshire rock-salt and evaporated brine, or in Mr. L. Horner's analysis of the brine from the springs of Droitwich in Worcestershire. In the last Number of the Phil. Mag. and Annals, however, Dr. Bigsby, in his Sketch of the Geology of Lake Ontario, has given (at p. 341) the results of an analysis, by Dr. M^c^Neven, of New York, of the "dry salt" from the brine-springs of Salina, a town between Liverpool and Onondago, near Lake Oneida; from which it appears to contain no less than 2·525 per cent of sulphate of potash. These results, Dr. Bigsby has had the goodness to inform me, were quoted by him from Prof. A. Eaton's Geological Survey of the District adjoining the Erie Canal, which was published in 1824; but they appear to have hitherto escaped the attention of chemical writers, as announcing the existence of potash in mineral salt.

Neither Dr. Henry nor Mr. Horner had occasion to institute any direct researches for potash in the salt and brine they examined. Dr. Henry, however, employed several processes for investigating the presence of alkaline sulphates, varying them according to the ascertained presence of other salts. Operating in this manner, had Dr. Henry possessed, when making his analyses, the accurate knowledge of the composition of the reagents and standards he employed, which, in com-

mon with all other chemists, he now enjoys, he could scarcely have failed to detect the presence of sulphate of potash in the varieties of salt, &c., he examined, supposing them to have contained it. But since his estimates of the constitution of sulphate of barytes and oxalate of lime, from which his deductions were made, are both slightly in error, it cannot be satisfactorily determined, from the merely general statements given in his paper, whether he would have detected an excess of sulphuric acid or not, by the processes and estimates he actually employed. It seems most probable, however, especially if the quantity were minute, that he would not have detected an excess of this kind. For example: the Lymington salt, as may be seen by recomputing Dr. Henry's results, might have contained 1·216 parts in 1000 of sulphate of potash without his detecting it*; and since the sulphate of potash of sea-salt must be one of those saline combinations which are chiefly left in the mother-liquor, we should not expect Lymington salt to retain more than a minute quantity, like this, of sulphate of potash, out of the proportion originally existing in the sea-water from which it is manufactured.

This reasoning extends to all Dr. Henry's analyses; not only of the rock-salt and the varieties prepared from the Cheshire brine, but also of the varieties of sea-salt, and of the *bitterns*, as well from brine as from sea-water, and of the impure kinds separated from both fluids during the crystallization of the muriate of soda. If the varieties of salt he examined contained muriate of potash, it must be included in what Dr. Henry regards, by estimation, as "pure muriate of soda."

But Mr. Horner, in his analysis of the Droitwich brine †, in which he found chloride of sodium, sulphate of lime, and chloride of magnesium, found also an excess of sulphuric acid,

* Dr. Henry obtained from 1000 grains of Lymington salt "31 grains of calcined sulphates, consisting of 19 grains of dry [anhydrous] sulphate of magnesia, and 12 grains of dry [anhydrous] sulphate of lime." "Now from the magnesian sulphate," he continues, "38 grains of sulphate of barytes should result, and from the sulphate of lime 21 grains, the sum of which is 59. But the quantity actually obtained was 59·8. There is only, therefore, an excess of 0·8 grain of the actual above the estimated quantity; a difference much too trivial to be admitted as an indication of any sulphate with an alkaline base: and arising probably from unavoidable errors in the experiment."—Phil. Trans. 1810, p. 115; or Phil. Mag. vol. xxxvi. p. 176.

Recomputation of these results: as 60 : 118 : : 19 : 37·366; and as 68 : 118 : : 12 : 20·823. The sum of these corrected results is 58·189 grains, which subtracted from 59·8 leaves 1·631 as the excess of the actual above the estimated quantity of sulphate of barytes. Now as 118 : 88 : 1·631 : 1·216, which, therefore, is the proportion of sulphate of potash in the Lymington salt that might have escaped detection.

† Trans. of Geol. Soc. 1st series, vol. ii.

which

which, having previously ascertained that neither uncombined acid nor sulphate of magnesia was present, he considered as indicating the existence of sulphate of soda in the brine; without taking any means of determining whether another alkali might not be present. By recomputing the numerical results he obtained, according to our present knowledge of the constitution of the various salts in question, employing Dr. Thomson's table of equivalents, as given by Mr. R. Phillips in the Annals of Philosophy, N. S., vol. x. p. 293, this excess of sulphuric acid may be shown to amount to 3·909 grains in the quantity of *entire* salt (resulting from the evaporation to dryness of the brine) examined by Mr. Horner. Now it is at least quite as probable that this excess of sulphuric acid should be owing to sulphate of potash as to sulphate of soda; if indeed it be not assignable with greater probability, to the presence of the former salt. This may be seen from the following statement.

On recomputing Mr. Horner's results, it will be found that the 431·860 grs. of entire salt analysed, contain, of

Chlorine	251·235
Sulphuric acid	7·457
Lime	2·484
Magnesium	0·080

the quantity of soda being merely inferred, as usual.

The magnesium is evidently in the state of chloride in the salt: 0·080 of magnesium combine with 0·240 of chlorine, becoming 0·320 of chloride of magnesium. This leaves 250·995 of chlorine, which unite with 167·305 of sodium to become 418·300 of chloride of sodium*.

Again: 2·484 of lime require for their conversion into sulphate of lime 3·548 of sulphuric acid, forming 6·032 of the sulphate.

We thus find that the proximate constituents of this *entire* salt, neglecting the excess of sulphuric acid, are

Chloride of sodium	418·300
——— magnesium	0·320
Sulphate of lime	6·032
	424·652
Deficiency	7·208
	431·860

* It would have been inconsistent with the truth of chemical science, if, in recomputing Mr. Horner's analysis, the terms and appropriate numbers for chlorine, magnesium and sodium, had not been substituted for those of muriatic acid, magnesia, and soda. But no opinion is meant to be expressed as to the actual state of combination in which the elements of the muriatic salts exist in the brine. The true state of the general question on this subject appears to be, that some chlorides are converted into muriates by solution in water, while others, when in solution, retain the chloridic form.

Towards

Towards this deficiency we have the 3·909 of sulphuric acid, yet unappropriated. If we suppose this to be combined with potash, we shall have 8·599 of sulphate of potash, being no more than 1·391 in excess, on the entire quantity of salt analysed. If we suppose it to be combined with soda, we shall have 7·081 of sulphate of soda, which is only 0·127 in defect, on the entire quantity.

Mr. Horner quotes Nicholas, Hassenfratz, and Montigny, as stating sulphate of soda to be a constituent part of all the (foreign) brine-springs they examined. But they had no reason to suspect the presence of potash; and when we consider that from the state of chemical science when they operated, they must have employed very defective methods of analysis, it is quite as probable that Nicholas and Hassenfratz attributed to sulphate of soda the acid really due to sulphate of potash, as that the former salt existed in the brines analysed by them; while Montigny, whose analysis was made so far back as 1762, no doubt obtained his sulphate of soda, by the action upon each other of the saline constituents of the brine during evaporation.

If the Droitwich brine contains muriate of potash, it must be included in what Mr. Horner estimates as muriate of soda.

In the Phil. Mag. vol. lxiv. p. 74, will be found the results of Mr. G. Chilton's analyses of some of the principal brine-springs in the State of New York, with an account of the process he employed. He neither mentions potash nor any alkaline sulphate; and had the latter existed in the brine, his process would have enabled him to detect it, if he employed correct equivalents; which, from the date of his analysis (1824), it is to be presumed he would. Muriate of potash he would not have detected*. In Dr. Beck's analysis of the entire salt from Salina brine, quoted in Mr. S. Smith's notice of the salt-springs at that place (Silliman's Journal, vol. xv. p. 11), neither potash nor any alkaline sulphate is mentioned. The mode of analysis employed is not quoted. How far the details of Klaproth's analyses of brine-springs may throw light on this subject, I am not aware.

To complete this summary of our present knowledge on this interesting subject of chemical inquiry, which has been drawn up with the view of showing the necessity of instituting fresh researches upon it, I add the following notices.

Dr. Wollaston detected traces of potash in the nearly satu-

* It is a remarkable circumstance, if Mr. Chilton's analysis be correct, that the springs he examined are in the same district as those of Salina, and rise under precisely similar geological circumstances.

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rated water, in many respects strongly resembling that of the Dead Sea, of the Lake Ourmia, or Lake of Shahee, in Persia, Phil. Trans. 1819, p. 194.

In the Phil. Mag. and Annals, N. S. vol. ii. p. 232, will be found the results of C. G. Gmelin's analysis of the water of the Dead Sea, which he states to contain 1·6738 per cent of chloride of potassium, without mentioning sulphate of potash.

A train of research instituted for the purpose of ascertaining whether all the saline constituents of sea-water are to be found, and in the same proportions, respectively, in rock-salt and in brine-springs, would be of great interest in a geological point of view; since, although obvious inference and many circumstances attending the deposits of rock-salt refer their origin to the ocean, yet there are difficulties affecting the most plausible theories of their formation, which a minute comparison of the constituents of rock-salt, &c., with those of sea-water, would probably tend to remove.

The quantity of sulphate of potash which Dr. Wollaston found in sea-water, by an approximative method, is in the proportion of 2·163 per cent of the total quantity of saline matter contained in it*. Now this quantity differs only 0·362, in defect, from that assigned by Dr. M^c^Neven to the entire salt of Salina; and it differs only 0·172, in excess, from the proportion of the same salt in the evaporated Droitwich brine, assuming the excess of sulphuric acid detected by Mr. Horner to exist in it in combination with potash. This near accordance, perhaps, may be regarded as confirmatory of the truth of that assumption.

It is probable that the potash in sea-water does not arise exclusively from the source suggested by Dr. Wollaston, since that alkali is a constituent, and in no inconsiderable proportion, of the oldest rocks. But even if we should prefer to ascribe its presence in sea-water wholly to the decay of plants, still there is no difficulty in conceiving its introduction, by the same means, into the waters of the primæval ocean, from which, by whatever operation of nature, and whatever changes may subsequently have been induced, the beds of rock-salt must originally have been deposited. For we know that land and

* Dr. Wollaston found sea-water of the specific gravity of 1026·22 to contain about $\frac{1}{1200}$ of sulphate of potash. (Phil. Trans. 1819, p. 201.) And from Dr. Marcet's experiments (Ib. p. 202) it will be found that sea-water of this density must contain 19·28 grains of saline matter in 500 of the water.

Now $\frac{500}{1200} = 0{\cdot}417$ very nearly, which is the quantity of sulphate of potash contained in 500 grains of sea-water, or in the 19·28 grains of saline matter which they hold in solution. Therefore as 19·28 : 0·417 : : 100 : 2·163.

fresh-

fresh-water plants, of several orders, existed in abundance, prior to the formation of the new-red-sandstone strata, in which the beds of salt occur.

On reviewing the chemical history of these subjects, it appears, in conclusion, that a series of new and exact researches on the contents of sea-water and of the rock-salt and brine of all countries, is now required by science. Subordinate to this would be required an investigation of the interesting points involved in the following: viz. the limits of compatibility with each other of the various salts concerned, their mutual action during the evaporation of solutions containing them, and the state of combination in which the elements of the salts obtained from sea-water actually exist in that fluid. The last labours of Dr. Murray (Trans. Roy. Soc. Edin. vol. viii.) and Dr. Marcet, in particular, especially so far as relates to the second of these subjects, require to be examined and reconciled.

16, St. James's-street, Clerkenwell: May 5, 1829.

LXI. *On the Specific Gravities of Compound Bodies.* By the *Rev.* J. B. Emmett.

To the Editors of the Philosophical Magazine and Annals.

Gentlemen,

HAVING had occasion to institute some inquiries into the specific gravity of certain compounds, I have found that some highly erroneous tables computed by Hassenfratz are generally adopted. The errors arise from two sources. Where substances which are soluble in water are concerned, a known quantity was accurately weighed in air, and afterwards in a bottle filled with mercury. It is well known that on account of the air contained in porous bodies, such as lime, hydrate of lime, magnesia, calcined alum or borax, and small crystals, as well as on account of capillary action, mercury does not enter into the pores; and consequently the resulting specific gravity is not that of the solid matter, but that of the volume made up of the mass of solid matter and of the pores or interstices together. The error is often very great: for example, Hassenfratz assigns the specific gravity 0·4229 to calcined alum, although the powder sinks rapidly in water: also, the specific gravity of the powder consisting of lime 2 and water 1, he gives 0·8983; yet this powder sinks in water. The specific gravity of lime must exceed his estimate 1·4558; for the specific gravity of its carbonate is 2·7; it consists of 26·5 lime and 20·7 carbonic acid; this acid escapes during calcination, yet the volume is but little altered; hence in this porous state its gravity will be about 1·5: in this state it mechanically absorbs a large quantity

quantity of water; or it is susceptible of condensation by pressure; therefore the real gravity of lime is higher than that which is assigned to it. Such substances should be weighed in oil, alcohol, æther, a saline solution which has no action upon it, or other liquid which will fully penetrate into the pores; and in some cases there may be occasion to place the liquid with the solid matter immersed in it under the exhausted receiver for a few minutes, to abstract the air, which is powerfully retained by the pores.

The other error arises from the formula which Hassenfratz has employed. This formula I have not seen: the following is that which I have used.

Let m and n represent the weights of two substances; a and b their specific gravities; c the gravity of the compound: the volume of the compound $= \frac{m}{a} + \frac{n}{b} = \frac{mb+na}{ab}$: but since the specific gravity of a mass of matter $= \frac{\text{its weight}}{\text{its sp. gr.}}$; $\frac{\overline{m+n}.ab}{mb+na} = c$; which is the same with Newton's. If the specific gravity of one of the ingredients be required, we have by transposition, $b = \frac{nac}{\overline{m+n}.a-mc}$. The following table exhibits the computed specific gravity of some metallic sulphurets by Hassenfratz; their true specific gravity; and that computed by the formula just quoted.

Sulphuret of	Computed Gravity by Hassenfratz.	True Gravity.	Gravity computed by Newton's Formula.
Silver	9·22	7·2	6·79
Mercury	11·83	10·0	9·4
Iron 1st	5·62	4·518	3·7
—— 2nd.....	4·73	4·83	3·0
Lead	10·06	7·0	6·9
Bismuth	8·65	6·131	5·7
Antimony	5·53	4·368	4·2
Arsenic 1st...	7·05	3·225	4·6
—— 2nd..	7·05	5·315	3·6
Molybdenum	5·97	4·73	3·5

The first three columns are copied from Thomson's Chemistry, vol. iii. p. 136, edit. 1817.

From the computed numbers of Hassenfratz, it would ap-

pear, that, with the exception of the deutosulphuret of iron, there is a great expansion during combination; or that the compound is much lighter than it ought to be, according to calculation; whereas the calculated, except that of the protosulphuret of arsenic, is always less than the true density; which by analogy might be expected.

The same philosopher has constructed a table of the specific gravity of certain saline solutions. (See Thomson's Chemistry, vol. iii. p. 97.) He gives the weight of the salt; the specific gravity of a saturated solution; the proportion of the ingredients; and the specific gravity of the salt in the solution, supposing, in all probability, that the salt alone suffers expansion or contraction during solution; or calculating what must be the specific gravity of the salt, did no expansion or contraction take place. I have calculated a few of the numbers by the above formula.

Sulphate of Potash.		Diff.
Hassenfratz's computation.....	1·859	— ·5483
True specific gravity.....	2·4073	
Computed by Newton's formula	5·39	+2·9827

Muriate of Barytes.		Diff.
Hassenfratz	1·937	— ·889
True gravity	2·826	
By Newton's formula	3·84	+1·014

Muriate of Zinc.		Diff.
Hassenfratz	1·773	+ ·196
True gravity	1·577	
Newton's formula	1·925	+ ·348

Nitrate of Potash.		Diff.
Hassenfratz	1·628	— ·3089
True gravity.....	1·9369	
Newton's formula.....	2·19	+ ·1531

In these cases, which might easily be multiplied, there is a manifest condensation during solution: however, no precise conclusions can be drawn until the specific gravity of crystallized salts shall be determined by a method which is free from sources of fallacy.

In the following table I have given the specific gravity of saturated solutions of various neutral salts, experimentally ascertained, from Thomson's Chemistry, vol. iii. p. 97, and the density calculated by Newton's formula.

By inspection, it is manifest that condensation takes place in all cases, except those marked + : yet, since the specific gravity of the salts is probably in most cases greater than that given

given by the table, the density calculated in the last column of this table is perhaps too small.

Name.	Sp. Gr. Solution.	Calculated Sp. Gr. Solution.	Name.	Sp. Gr. Solution.	Calculated Sp. Gr. Solution.
Sulphate of Soda	1·060	1·032	Nitrate of Lime.....	1·143	1·109
Potash...	1·055	1·038	Barytes...	1·047	1·045
Alumine	1·026	1·023	Zinc	1·489	1·427
Magnesia	1·294	1·269	Copper...	1·530	1·439
Iron.....	1·219	1·180	Acetate of Soda.....	1·189	1·373+
Zinc	1·373	1·360	Lime.....	1·098	1·0009
Copper ..	1·189	1·151	Magnesia	1·252	1·159
Muriate of Soda	1·210	1·195	Alumine	1·107	1·021
Potash...	1·145	1·173+	Iron	1·134	1·096
Ammonia	1·070	1·093+	Lead.....	1·198	1·174
Lime	1·351	1·302	Tartrate of Soda.....	1·196	1·165
Magnesia	1·272	1·321+	Potash...	1·435	1·284
Barytes ..	1·265	1·22	Phosphate of Soda.....	1·030	1·020
Zinc.....	1·607	1·404	Borax	1·013	1·014+
Copper...	1·271	1·194	Soda of Commerce	1·158	1·125
Nitrate of Soda.....	1·231	1·216	American Potash.....	1·301	1·259
Potash ...	1·157	1·035			

I take the present opportunity to correct a considerable error committed in Brande's Chemistry. In p. 23 (edit. 1819) there is a table of the expansion of gaseous matter: in it the intervals of temperature are equal, and the expansion proceeds according to the terms of an arithmetical series, whose common difference is 208. In p. 118 the rule is given for reducing the volume at any temperature to the volume at some standard temperature: "Divide the whole quantity by 480; the quotient will show the amount of its expansion or contraction by each degree of Fahrenheit's thermometer. Multiply this by the number of degrees, which the gas exceeds or falls below 60°. If the temperature be above 60°, subtract; if below 60°, add the product to the absolute quantity of the gas." Now 208, the common difference, is the 480·76th part of 100000, the assumed volume at 32°; it is only the 508·76th part of 105824, the volume at 60°: therefore, were the formula correct, 508·76 should be the divisor, if the volume were to be reduced to the temperature 60°. But the formula is erroneous; for the increment answering to an increase of 1° is assumed the 480th part of the whole, *i. e.* at 32°, the 480th part of 100000; at 212° the 480th part of 137440. By the rule, the volume at 212° being 137440, find the volume at 32°; and it is found to be 85901, instead of 100000. The following formula will be applicable to the table given by Brande, and most chemists.

Let a = volume of gas at a standard temperature as 32°; V = the volume at some other temperature: $\frac{a}{n}$ = increment by elevating the standard 1°; m = number of degrees above or below the standard. Then $a \pm \frac{m\,a}{n} = \mathrm{V}$. or $a = \mathrm{V} \times \frac{n}{n \pm m}$.

Yours, &c.

J. B. Emmett.

LXII. *On the Perspective Representation of a Circle. By* John William Lubbock, *Esq. F.R.S. & L.S.**

LET $\phi\,(x,z,y)$, $\phi'\,(x,y,z)$ be the equations to any curve line; let the eye of the spectator be situated at the origin of the co-ordinate axes, and let x', y', z' be the co-ordinates of any point in the conical surface whose vertex coincides with the origin, and whose base is the curve in question. The equation to this cone is found by eliminating x, y, z from the equations $\phi(x\,y\,z)$, $\phi'\,(x,y,z)$, and $x' = \frac{x,y'}{y}$, $x' = \frac{x\,z'}{z}$.

Let ϕ and ϕ' be the equations to a straight line

$$\begin{aligned} a\,y &= b\,x + \alpha \\ a\,z &= c\,x + \beta \end{aligned} \qquad (1)$$

The equation to the plane passing through the origin and this straight line will have for its equation

$$\beta\,(a\,y' - b\,x') = \alpha\,(a\,z' - c\,x')$$

The equation to any straight line parallel to line (1) will be

$$\begin{aligned} a\,y &= b\,x + \alpha' \\ a\,z &= c\,x + \beta' \end{aligned} \qquad (2)$$

a, b, c which depend on the direction of the line being the same, and the equation of the plane passing through this line will be

$$\beta'\,(a\,y' - b\,x') = \alpha'\,(a\,z' - c\,x') \qquad (3)$$

The equations of the line which is the intersection of these planes are

$$\begin{aligned} a\,y' - b\,x' &= 0 \\ a\,z' - c\,x' &= 0 \end{aligned}$$

which are the equations of a straight line parallel to lines (1) and (2) and passing through the origin.

The representation of any line is the intersection of the surface of the picture, and the plane $\beta\,(a\,y' - b\,x') = \alpha\,(a\,z' - c\,x')$. But it is evident, in consequence of the preceding theorem, that the representations of all lines which are parallel, will meet in the picture in the point where the line $\left\{\begin{matrix} a\,y = b\,x \\ a\,z = c\,x \end{matrix}\right\}$ cuts the surface, whatever this surface may be. If the picture is a plane of which the equation is $x = \mathrm{A}$, the equation to the re-

* Communicated by the Author.

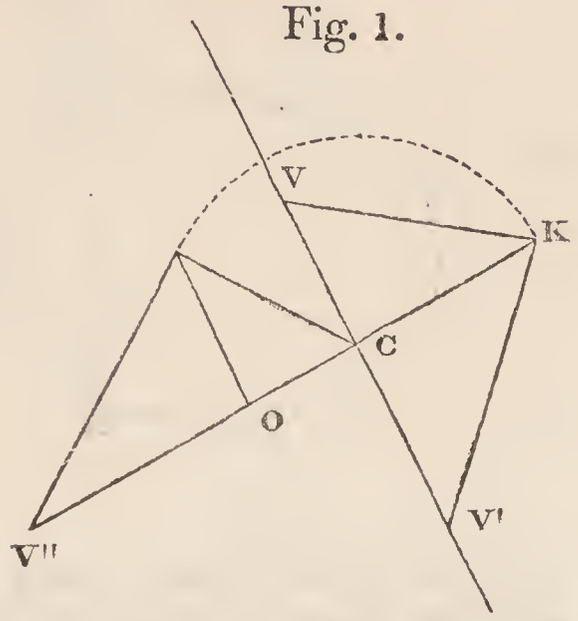
pre-

presentation of the line in the drawing referred to co-ordinate axes, O y coinciding with the intersection of the picture and the plane $x\,y$

O z coinciding with the intersection of the picture and the plane $x\,z$

is $\beta(a\,y - b\,\mathrm{A}) = \alpha(a\,z - c\,\mathrm{A})$; and the coordinates of the vanishing point of this line are $\frac{b\,\mathrm{A}}{a}$ and $\frac{c\,\mathrm{A}}{a}$; it is easy to show that the vanishing points of all lines which are situated in the same plane are in the same straight line, which line is called the vanishing line of the plane.

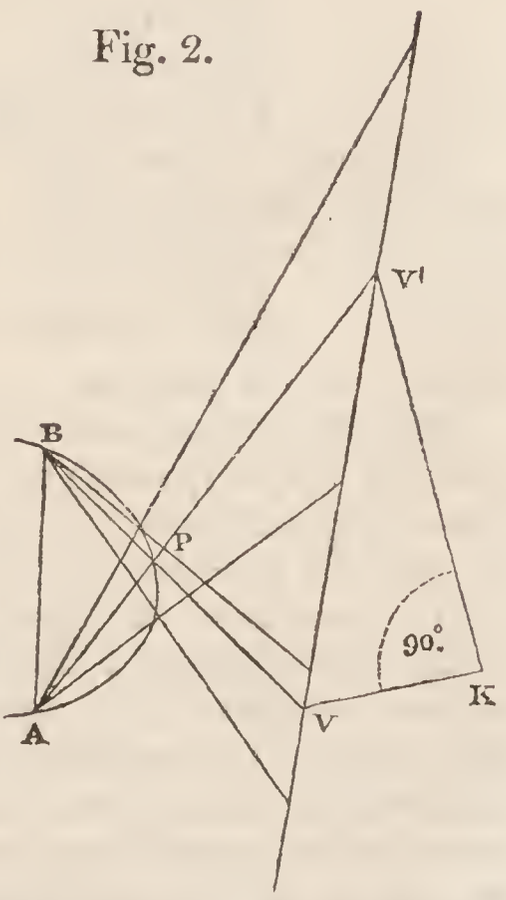
Fig. 1.



It is evident from the preceding theorems: that if V and V′ (fig. 1.) are the vanishing points of any two lines, and if OCK be drawn perpendicular to V V′ cutting it in C, and if CK be taken so that $\mathrm{CK}^2 = \mathrm{OC}^2 + \mathrm{A}^2$, the angle VKV′ is equal to the angle contained by these lines. This theorem is the foundation of the whole practice of perspective.

Suppose it were required to draw a circle; having drawn any diameter AB and VV′ (fig. 2.) the vanishing line of the plane in which the circle is situated by making the angle VKV′ constantly equal to a right angle, and joining AV, BV′, as many points as required may be found by the intersection P of AV and BV′; and this is also perhaps the simplest method of describing the curves of the second order. If the chord AB is given of a segment including any given angle, the same construction obtains, making VKV′ = to this given angle. If the circle which is to be represented be wholly without a plane passing through the eye of the spectator and parallel to the picture, the representation will be an ellipse, if it only meet this plane it will be a parabola; if it cut the plane it will be a hyper-

Fig. 2.

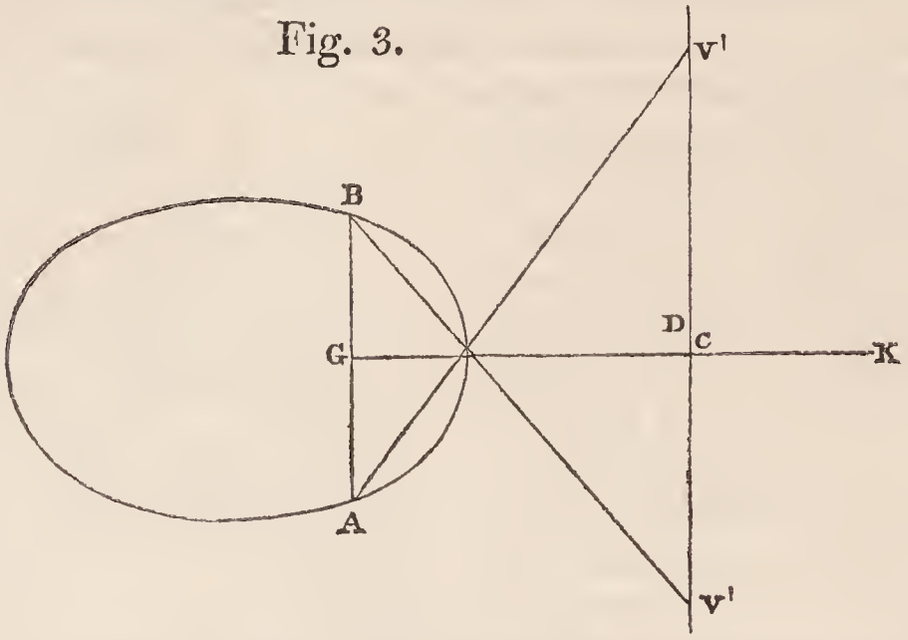


a hyperbola. Thus to a spectator in an amphitheatre the inner benches are in the picture ellipses, the bench on which he is seated is a parabola, or nearly so, and the outer benches are hyperbolas.

The following construction obtains generally for curves of the second order:

Let any straight line AGB (fig. 3.) be bisected in G, at G draw GC perpendicular to AB, cutting VV′ in C, in VV

Fig. 3.



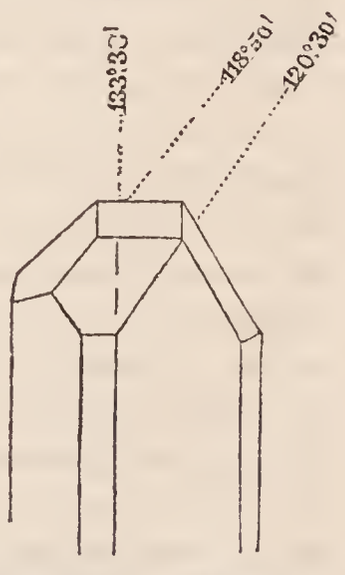
take any point D, and make DV = DV′ = DK. Join AV, BV′ the locus of the intersection of the lines AV, BV′ is a curve of the second order.

If VV′ is parallel to AB, and

KC > GA, the curve is an ellipse,
KC = GA, the curve is an parabola,
KC < GA, the curve is an hyperbola.

It is easy to show that if VV′ is the vanishing line of any plane, the vanishing point V″ of a line perpendicular to this plane is found by taking in OC, fig. 2. $V''O = -\frac{A^2}{OC}$, A being, as before, the distance of the picture.

Fig. 4.



Spherical triangles may be solved graphically by perspective by means of the preceding theorems; but this application is without practical utility, and is too simple to require development.

In crystallography, it might be convenient to mark the angles contained by planes at the vanishing point of the lines which result from their intersection, or any point in them lines produced, as in (fig. 4.) which is *Stilbite*, (Phillips's Mineralogy, page 37.)

The

The construction of a sun-dial is a very simple problem in perspective. In fact, if OE and KCOG (fig. 5.) are perpendicular to each other, if OE = the height of the style; OEG the angle which the polar axis makes with the style, which, when the dial is horizontal, is the colatitude of the place; CK = EC, the nth hour-line or GV_n is found by making the angle $CKV_n = n \times 15°$, and joining GV_n. The curve which the extremity of the sun's shadow describes may be thus found:

Draw AGB (fig. 5.) perpendicular to OG. Make GD in GC = GE, and let ADG = BDG = sun's codeclination.

Let $CKV_5 = 75°$ $\quad CKV'_5 = 7° 30'$
$CKV_4 = 60°$ $\quad CKV'_4 = 22° 30'$
$CKV_3 = 45°$ $\quad CKV'_3 = 37° 30'$

$CKV_n = n \times 15°$ $\quad CKV'_n = (n-5)\ 15° + 7° 30'$.

Join BV'_1 cutting GV_1 in P_1

P_{n-1}, P_n cutting GV_n in P_n,

P_1, P_2, &c. P_n are points in the curve.

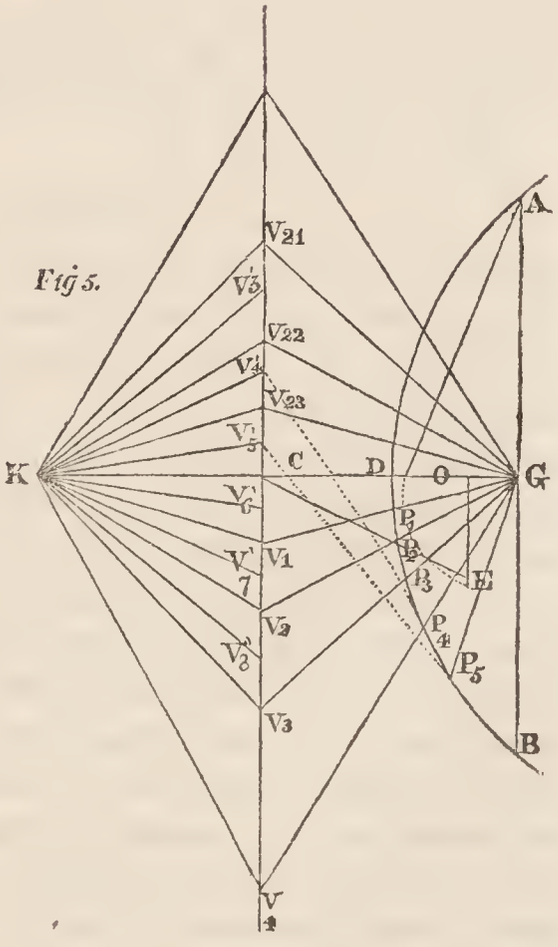


Fig 5.

The problem is the same as to represent on the dial a circle situate in a plane of which VCV′ is the vanishing line; EO the height of the style, being the distance of the picture, and the circle such that a perpendicular from the eye of the spectator meets the circle to be represented in its centre. This circle is in fact the circle described in the heavens by a sun whose right ascension and declination are those of the real sun +180°.

The extent which a picture ought to take in, must of course be regulated by the field of view. Objects are not seen distinctly by the human eye, which subtend an angle greater than 45° with the visual axis; therefore the limit of the picture should be such that it does not contain the vanishing point of any line which makes an angle greater than 45° with the axis of vision. If objects are delineated which are beyond this boundary, the perspective becomes *distorted*, and does not convey to the mind an accurate idea of the object which is to be represented. In representing the

the sphere of the heavens, for instance, if one hemisphere be projected on the same plane, the form of the configurations of the stars is entirely lost, and the *map* ceases to bear any resemblance to the appearance presented to the eye. This would not be the case if the sphere were projected upon six planes forming the sides of a cube, the eye being supposed at the centre. The distortion at the corners would be too trifling to interfere sensibly with the effect to be produced. The heavenly sphere would thus be contained in six maps, which would have the advantage of enabling any one to find any star or constellation with the greatest readiness. If the pole be taken for the centre of the upper surface of the cube, and the *maps* be divided by meridians and parallels of declination, the sides of the cube are symmetrical, the parallels of declination are portions of hyperbolas, and the meridians are straight lines; the upper and lower surfaces are also symmetrical, the parallels of declination are circles, and the meridians are straight lines.

LXIII. *A Sketch of the Topography and Geology of Lake Ontario. By* J. J. Bigsby, *M.D. F.L. and G.S., For. Mem. Amer. Phil. Soc. &c.*

[Concluded from p. 347.]

THE next place at which I have met with conglomerate is seven miles above this strait, close to a well-marked bluff promontory. Here the cement is in great quantity; and is clay, coloured by chlorite: the quartz nodules are often red, and are both rounded and angular. It is at the water's edge. Some hundred yards below the deposit of schorl on Mr. Mackenzie's farm before spoken of, elevated strata of milky quartz-rock make their appearance on the beach, accompanied by the granular gneiss, containing schorl and chlorite. Resting in close contact on the quartz is a coarse conglomerate of the same materials, in a green cement; and above it is an horizontal brown limestone, full of quartz nodules at the bottom of the ledge, but which, gradually diminishing in number and size, disappear almost wholly in the upper layers. This very coarse conglomerate of milky quartz forms a ledge fifteen feet high, about three hundred yards south-west of the same deposit of schorl, close to a creek on Mr. Mackenzie's farm, and is again filled with fragments of the last-named mineral. It is in this case surrounded by debris and soil, and therefore is, as far as we can observe, unconnected with any rock. These puddingstones seem to be merely local deposits, thick and extensive as we have seen them to be; for on the shores of the outlet

outlet near and east of Kingston, in numerous places, limestone rests upon the gneiss without the intervention of a third rock; and on the slope of Point Henry under the west side of the Fort, the primitive rock is immediately overlaid by a breccia, whose remarkably angular fragments are of the greenstone and sienitic gneiss (or granite) of the place exclusively. I observed that the cement was a somewhat crystalline limestone, and that the large and small fragments were kept separate. Very little of this breccia is visible, neither can there be much; for it is surrounded by fixed masses of the gneiss and of limestone, horizontal or slightly inclined to the west. Shreds of this last rock are occasionally seen attached to the gneiss of the promontory close to Cedar Island and (as before mentioned) in parts of the outlet. Its adhesion is so strong that it is easy to obtain hand specimens composed of both rocks in firm union. The age of this sandstone is determined by that of the limestone incumbent on it to be that of the old red sandstone. The limestone in every circumstance but its horizontality (or near approach to that position) is similar to the carboniferous of England. Their most characteristic organic remains and minerals are the same; as also their relations, at least to the rocks beneath them.

In the same form as on the lake shore, this limestone (whose situation and characters we shall now trace) occurs in the valleys and small elevated plains interspersed in the adjacent primitive formation. It is horizontal, as far as the eye can judge, and never under the sandstone or conglomerate. From Brockville upwards, it skirts the outlet at some distance from its banks, which are always (except as noted above) of sandstone and gneiss; thus the eminence in the rear of that town is calcareous, while the cliffs in front and on its east are arenaceous.

The town of Kingston is based upon it, and it is to be traced westerly for seventy miles to the Portage of the Bay of Quintè at least, and southerly to the south shore of Lake Ontario; while in the two remaining directions it terminates on the older inclined rocks. At Kingston it forms extensive and high platforms behind the town, which first by a ledge, and then by broken shelves, gradually descend towards the shore to the level of the lake. Points Frederic and Henry are faced by it in low precipices; and the latter has many quarries of it in the hill east of the fort. The lake of the mountain in the Bay of Quintè is underlaid by this limestone, and discharges into the bay over a precipice (at a rude guess) 120 feet high. I had no opportunity of examining this locality; but was more fortunate at Hallowell, about thirty-six miles west of Kingston,

where at a wharf there is a steep limestone rock about ninety feet high, but not absolutely perpendicular.

On the peninsula of Prince Edward, I am informed there are some very high cliffs; I have not seen them. Quintè Portage, and the Presquisle Point, three miles W. of it, rest upon this limestone. The north main adjoining Quintè Bay is in gentle undulations, occasionally high enough to be called ridges. It is highly fertile, and supports an opulent yeomanry. The River Nappanee, thirty miles west of Kingston, besides presenting some remarkably pretty scenery, exhibits at its lowest Falls a fine vertical section of the limestone.

At Kingston there is discovered at least one hundred feet perpendicular of this rock; I believe that the form in which it is found here may be taken as a type of the whole, with some exceptions to be stated afterwards. Its layers are from six to eighteen inches thick, with rough floors and roofs; often coated with a thin black glaze which scales off: occasionally they are quite shaly. "The subdivisions in the strata, which from their singular shape have been called sutures, are seen in most of them at this place; but they are very irregular in size and number: sometimes there are many in a small layer, and none in a large one. They are not continuous for any distance, but disappear in the form of a fissure. They are commonly, but not always, horizontal. They often form a sort of irregular knot (as in wood) in the middle of a stratum." (*Vide* Niagara, Geology of.)—The highest strata, those of the upper platform, are blue, fine-granular, of conchoidal fracture, and are everywhere crowded with a great variety of organic remains, while none are found below. The latter are studded, in most places, with small masses of hyaline calcspar (as at Marmora), and are usually of finer texture than those above, even so much so as to be quite compact, sharp-edged, and of highly conchoidal fracture. The hardness is also somewhat increased; and the colour changes to a brown, which in the middle and lower portions is quite a gray, with sometimes a greenish tinge. The strata near the beach are usually much weathered. The limestone of Point Henry adjacent, differs but little from that of Kingston, but is destitute of organic remains, although their respective highest layers are at nearly the same level; but those of Kingston have a much greater body of rock interposed between them and the gneiss than the strata of Point Henry, which are only a few feet distant at most. The inferior layers of this point are well developed in a quarry on the south of the fort. It is blue at the top, then greenish and more granular (as if weathered) for four or five feet; then clove-brown for more

more than a foot, when the green form returns for the same thickness as before, and is followed by the common pale-brown limestone down to the beach.

The blue limestone of Catarroque (one to three miles W. of Kingston, and ten to thirty feet above the lake), with that of the higher parts of Point Henry and of the terraces among the primitive rocks ten miles N.E. of Kingston, contain large masses of red and white calcspar, with octohedral iron pyrites imbedded or in druses, and of fibrous celestine under similar circumstances. Sometimes the celestine is by itself in balls from an ounce to ten pounds in weight, in promiscuously aggregated bundles of closely compacted fibres of a beautiful sky-blue colour, of a silky lustre and often pale. Geodes of trihedral pyramids of calcspar are not uncommon, with a delicate network composed of the fibres of celestine running along the apices of the crystals. The cliffs and ledges of brown limestone on the shores of the outlet on Mr. Law's farm contain shapeless masses of white foliated strontian. I have not met with this mineral in any other part of the north shore of this lake. It is plentiful in other forms, in this and more recent limestones, in different parts of the valley of the St. Lawrence. The varieties to which I have alluded, consist of the large crystalline brown kind full of shells, found at Stony Island near Sacket's Harbour, Carlston Island, and at Quintè Portage. It is usually in the upper layers. For ten miles west of the village of Bath (miles W. of Kingston) there are several naked patches of brecciated limestone, the masses being pale blue and brown, while the cement is of the same colours, but much darker. In the woods between Marmora works and Lake Ontario this breccia is not at all uncommon in the state of displaced (but not rolled) fragments. Its situation in the carboniferous limestone of this vicinity I do not know. The Hallowell limestone is of a dull leaden brown, and is in thin layers. It contains the *conularia* so characteristic of the above-mentioned rock.

In regard to the succeeding rocks of Mr. Eaton's series, I have met with nothing indicative of the presence of his grauwacke and millstone grit, either in a fixed or loose state; further inquiries may find them: while nothing like his ferriferous slate and sandstone are visible, the saliferous rock undoubtedly prevails throughout the north shore, both in the immediate vicinity of the lake and as much as twenty miles in the rear. As far as I am aware, it is only detected by its springs. The first intimation of their existence is usually given by cattle. They occur in swamps, ponds, and running brooks in the woods, where no strata are in sight, and where those close at hand

and on the same level contain *productæ*, *orthoceræ*, trilobites, &c. They are tolerably copious; and although weak at the surface are more concentrated below, where they are no longer diluted by rains and infiltrations. The following are the situation of the springs of which I have received intelligence; but I confess that I have not hitherto made sufficient inquiries.

In the centre of the township of Elizabeth's Town, on the east of the primitive band crossing the lake of the Thousand Islands, there is a spring (Gourlay, vol. i. p. 511); another, together with gypsum, in Ernest Town on the shores of the lake (Gourlay, vol. i. p. 483); another in Sophia's Burg on Prince Edward's Peninsula (Gourlay, vol. i. p. 146). Besides many smaller salt licks, in front of lot, No. 10, in concession B of the township of Murray, one and a half to two miles N.W. from Quintè Portage, there is a saline spring which discharges as much as a common pump. It has been penetrated for sixteen feet, and yields about a peck of salt for every seventy gallons of water; but it is supposed to be weakened at present by the stagnant brackish water which surrounds the spring in patches for a quarter of a mile square.

There are several salt springs in the township of Percy, county of Northumberland, at which much salt was made during the war between Great Britain and the United States. There are several also in the township of Whitby, in the East Riding of the county of York, issuing from clay and increasing in strength with the depth from which they are raised. Others are at Chinkecushè on the River Credit in the township of Toronto; in the seventh concession of Esquising; and many about Burlington Bay; and at St. Catharine's on the west shore of the lake; some of which are worked, and will be noticed hereafter. Nothing but capital, and a little practice, is wanting for them to be as productive as the saline springs of the State of New York.

The unbroken continuity to at least three miles beyond Quintè Portage of the carboniferous limestone of Kingston, incumbent on gneiss, renders it very difficult to account for the presence of salt in Ernest Town, Adolphus Town, and in Murray. I think that in this interval I have seen the rock in undisturbed horizontality at least every three miles, and characterized by its peculiar organic remains in the clearest manner. Among them are, *conularia*, Llandilo, and trilobites (*Asaphus*) *turbinitæ*, *productæ*, *orthoceræ*.

This difficulty is felt particularly in Murray, where the carboniferous limestone is quite near, and I believe floors the low marsh in which the springs appear.

To suppose that the strata at and for three miles west of Quintè

Quintè Portage dip to the N.W., would relieve us from the dilemma by placing the salt rock above them; but the shreds of limestone visible in those places are horizontal: neither is it usual for the newer rocks to incline towards those more ancient supporting them, they usually incline from them.

In the basin of Lake Ontario, we have not so decidedly the aid of the organic remains in investigating the relative ages of the strata. There is no doubt of the situation of the carboniferous and calciferous limestones on the south shore; for instance, the former is beneath the salt rock, and the latter above it; yet they both contain orthoceratites, trilobites, *productæ*, &c. differing however in species.

Leaving these difficulties to be unravelled by future observers, I shall proceed to mention, that although I have carefully travelled over the distance, I have not seen fixed limestone from within three miles of Quintè Portage* to York (107 miles), excepting a few weathered strata at Hamilton's Creek (sixty-seven miles E. of York) and Port Hope (sixty miles E. of York). At these two places it floors the streams, and is both compact and crystalline in the same layer: it contains the fossils of carboniferous limestone, and so for the present must be arranged as such.

Near Still's Tavern, thirty miles east of York, and not far from the lake, I am told there is a small patch of black calcareous shale having chiefly trilobites imbedded in it. I did not visit the spot. This shale may belong to the calciferous slate of Eaton, above the saliferous and ferriferous rocks,—a supposition greatly strengthened by the nature and contents of the limestone about the fort at York, at the mouth of the adjacent River Humber, and for six or eight miles up it, where there are extensive quarries. Dr. Lyons, surgeon to the forces, informs me that it is in horizontal layers of moderate size, and that it contains the genus *Caryocrinites* of the *Crinoidea*. It cannot be distinguished in hand specimens from some of the calcareous beds in the calciferous slate; and now and then, like them, contains silvery scales, very small, of mica or talc. It is brown with a slight tinge of green, granular and hard. In addition to great numbers of large *orthoceræ*, *terebratulæ*, *productæ*, encrinital columns, &c. it contains also many *modioli*, and *plagiostomæ*, organic remains, which, with the encrinital stomachs just alluded to, have never been found in the carboniferous limestone of Canada, but frequently in the calciferous slate. The number of fragments of trilobites

* It is seen in broken ledges at the points, but chiefly under water and much changed. I had it not in my power to examine it.

occurring

occurring in some of the layers is inconceivably great, but they are too small to allow of the determination of the genus.

Such are the rocks of the north shore of this lake. We have seen that their examination is greatly embarrassed, if not altogether prevented, in the western half of the interval between Kingston and York, by morasses and extensive deposits of alluvion. The same obstacles, I learned, exist from York to the head of the lake; so that, discouraged also by the state of my health at the time I was in that neighbourhood, I did not proceed on the north shore further west than the last-named town.

The south side of the upper end of the lake, constituting part of the district of Niagara, I have examined carefully. I found the rich and beautiful stripe of low land between the lake and what is called the "mountain," to be underlaid by saliferous sandstone, in extremely thin and soft strata, red, green and blue, and very argillaceous. It is visible on the River Niagara at the Gorge of Queenston, and in the river bank at the town in great thickness. Many of the creeks between the Niagara and Burlington Bay have worn their way down to it; and the brackish waters called "deer-licks" are not uncommon. I visited one of these, three quarters of a mile W. by N. from the village of Stoney Creek. It is in a hollow, and is merely a quantity of muddy brackish water on a bottom of blue clay, evidently much frequented by animals, from the trampled state of the herbage and smaller trees around it. These strata come very fairly into view at Big Creek, eleven miles west of the village of Grimsby on the Forty-mile Creek. There are here two salt-works on a very small scale, belonging to Messrs. Kent and Macdougal. They are only a few hundred yards apart, and are both in a hollow, formed by the creek, but now, at least in autumn, deserted by it. The saline rock shows itself in a high scarp and some small crumbling ledges, and is quite in the usual form. Mr. Macdougal's works yield sixty-five bushels per week (1824), and could produce a hundred if necessary. The water is very weak, and scanty. The spring may be pumped dry in an hour. There is a well for the first twelve feet, and then a bore for seventy feet further. Mr. Kent's spring is in the same circumstances as the one just described. These few particulars I obtained from one of the workmen on the spot.

At the flourishing village of St. Catharine's, twelve miles from Queenston, there is another salt-work, close to the Twelve-mile creek, whose bed is 100 to 120 feet below the average level of the country, and flanked by steeps of red clay, sand, and quartz pebbles. It is in the red saliferous rock. The

boring

boring has been carried 250 feet below the surface, but with occasional changes in the strata. What these were I was unable to learn; Mr. Merritt, the proprietor, being absent at the time. While the water of the creek, only a few feet off, is quite sweet, that of the spring is very salt, and copious. It is sometimes very red. Fifty gallons make a bushel of salt, which is very white, and in small and thin irregular tables; 3640 bushels are made in a year, worth on the spot about 550*l.* sterling.

The Parallel Ridge, a mountain overlooking this flat, is composed of the same materials as the chasm of the River Niagara, which have already been declared to be, successively, from below, saliferous sandstone, ferriferous sandstone and slate, calciferous slate, and geodiferous limestone rock. I therefore refer the reader to my account of that river for any additional particulars respecting these strata that may occur in that ridge.

J. J. Bigsby.

LXIV. *On the Measurement (by Trigonometry) of the Heights of the principal Hills of Wensleydale, Yorkshire. By* John Nixon, *Esq.*

[Concluded from page 362.]

SOME time previous to the commencement of the survey, the great levels of the horizon-sector had been fitted up with scales divided into equal parts (of about two seconds each), numbered from the end of the scale the nearest to the eye-piece of the telescope progressively to the one next to the object-glass.

The zero of each index (carrying the levels) being placed exactly in a line with that of its graduated arch (fixed to the telescope), on which it moves, the following method was adopted in order to ascertain at what two divisions of its scale the bubble of each level would remain stationary on reversing the telescope within its Ys.

The sector, placed in the shade on a perfectly steady support (such as a rock or well-built wall), having acquired the temperature of the ambient air, the inclination of the telescope was varied until the bubble of either level; for instance, that of the right index, moved to about the middle of its scale. After a lapse of a few minutes, the divisions of the scale coincident with the two extremities of the bubble were read off and registered. In the second place, the telescope was inverted within its Ys, and the corresponding position of the bubble of the left-index level (now uppermost) read off. Lastly, the telescope

telescope being taken out of its Ys, and replaced reversed in position, the bubble of the left-index level, and afterwards, on inverting the telescope, that of the right-index level, were read off as before. The reversing point of the middle of the bubble of either level being evidently equal to one-fourth of the sum of the readings of the position of its ends in the direct and reversed positions of the telescope, two marks were made with a camel-hair pencil dipped in white paint on the tube of each level, one on each side of, and equidistant from the reversing point by half the length of the bubble.

The sector had been transported in the course of the survey in vehicles of every description over the roughest roads imaginable; yet the great levels, as will be evident from the subjoined statement of the position of their reversing points at the several stations, had retained their first adjustments to the accuracy of a second or two.

		Right Index.	Left Index.	Mean.
Reversing point at	Bear's Head	67°	74°	70°·5
———	Shunnor Fell ...	66	72	69
———	Bakestone Edge .	62·5	76	69
———	Penhill	65	76·5	71
—— (July 9th)	Settronside.....	61·5	76·5	69
—— (July 10th)	.....	65·5	75	70
			Mean	70°

Heretofore the vertical angle could not be measured until the ends of the bubble were made to coincide exactly with the reversing marks; but on the addition of scales to the levels, the angle read off could be corrected for any slight deviation of the bubble from its marks, by noting the contemporary position of the ends of the bubble. To understand the nature of this correction, it is to be observed, that when the telescope is pointed at an elevated object, and the index moved until the bubble of its level comes to rest at its marks, the zero of the index will be *lower* than that of the graduated arch (fixed to the telescope) by the arc of elevation. Consequently, on subsequently elevating the index in a slight degree, the two zeros will be brought nearer to each other; the displaced bubble, advancing in the direction of the object-glass, will come to rest with its middle point opposite a number in the scale exceeding that of the reversing point; and the angle of elevation now read off on the graduated arc, will be in defect by the angular displacement of the bubble. Hence the registered angles of elevation will require correcting by the difference in seconds of the half-sum of the readings of the position of the ends of the bubble and that of the reversing point; additive or subtractive

subtractive according as the half-sum exceeds or falls short of the reversing point. For angles of depression the correction is to be applied with the contrary signs. The value of one division (of forty to the inch) of the right-index level is 1″·91; that of the left-index level 2″·12.

On calculating the cylindrical error of the sector from measurements by the scales, substituted for those previously obtained by the divided arcs, its amount was determined to be 20″, instead of 11″ as last stated; the discrepancy arising principally from a gross error existing in the formula*.

The ground about the station at Penhill being an almost impassable bog destitute of rocks, the tripod of the theodolite, having a firm board screwed to it, was fixed on the turf-mound already described. From the elastic nature of the materials of the mound, the slightest change in the position of the observer displaced the bubble of the level several minutes, and threatened to render the accurate measurement of the angles utterly impracticable. Fortunately, after abandoning various plans of overcoming the difficulty, the following method of conducting the observations was tried and found to succeed extremely well. An approximate measurement being effected, the weight of the body was thrown for a moment on one foot, and a light stone, placed on the board, moved gradually in the proper direction until the line of collimation pointed exactly at the base of the signal. Averting the head as slightly as possible, the position of the bubble was then read off at one rapid glance, and the eye replaced as instantaneously at the telescope, to ascertain that its direction remained unvaried. Tedious and difficult as was the method in execution, it was gratifying to find that the results equalled in accuracy the measurements effected in the usual way at Settronside with the sector placed on a wall, or supported, as at the other stations, on firm piles of stones surmounted by a heavy flag.

The observed refractions, with their deviations from the mean value, about 1-17th, are stated below:

	Arc.	Refr.	Deviat.
Shunnor Fell and Bakestone Edge	4′ 19″	−17″	−32″
Bear's Head and Whaw Fell	4 36	+19	+ 3
Bakestone Edge and Bear's Head	5 6	19	+ 1
Penhill and Settronside	5 39	17·5	−2·5
Bear's Head and Shunnor Fell	5 51	12	− 9
Settronside and Bear's Head	6 20	27	+ 5
Shunnor Fell and Knoutberry Hill	6 21	16	− 6

* Some time in the course of the present year I hope to be able to furnish your readers with a complete treatise "On the constant Error of Collimation of a Telescopic Level."

	Arc.	Refr.	Deviat.
Dod Fell and Shunnor Fell	6′ 55″	19″	− 5″
Penhill and Bakestone Edge	7 40	26	− 1
Bakestone Edge and Settronside	8 47	41	+10
Bear's Head and Penhill	8 49	25·5	− 5·5
Penhill and Dod Fell	10 36	49	+12
Shunnor Fell and Settron Fell	11 38	37	− 4
Penhill and Pen-y-gent	12 40	40	− 5
Sum (rejecting the first)	1° 40 50	5′ 48	

Mean refraction 1-17th.

The registers of the measurements by the horizon-sector will require explanation. The *first* column contains the name of the hill of which the ground, unless otherwise stated, had been observed; the *second*, the mean of the readings by the two indices of the elevation or depression, each corrected for the constant error of the instrument and the deviation of the bubble from its reversing point; the *third*, the difference of level of the *cam* at Penhill, the walls at Settronside and Pen-y-gent, and the ground at the other stations and the summit or other given part of the observed hill; the latter being higher or lower than the former according as the difference is marked H or L.—The *last* column, given merely as a test of the goodness of the observations, exhibits the difference between the error of collimation of each (pair of) observations, and the mean error of the whole †.

At Settronside Wall.

The measurements marked* were made July 9th, 1828; a cold but clear day accompanied by a tremendous wind; the others were made on the following day, of which the earlier part proved remarkably bright and clear, but was succeeded by partial mists.

Height of the eye above the wall 0·5 feet.

			Feet.	
*Penhill, *Cam top*	51′ 22″	depr.	. . .	8″
———	51 15	——	489·0 L.	0
*Little Whernside	50 36	——	. . .	7
———	50 24	——	318·1	7
*Rover Crag	65 38	——	. . .	0
———	65 30	——	754·3	4
*Great Haw	50 46	——	518·8	1
Yockenthwaite Moor	37 35	——	195·2	4
Bear's Head	28 22	——	287·3	1
Lovely Seat	9 25	——	87·9	3

† In the calculations the refraction has been considered to be without exception 1-17th of the contained arc.

Bakestone

					Feet.		
Bakestone Edge		28′	16″	depr.	379·3	L.	4″
Caldberg Moor†		67	0	——	946·7		2
Whitfield Hill, *Wall top*		54	10	——	948·3		2
Wasset Fell	2°	11	28	——	429·7		5
Stake Fell	1	22	25	——	463·2		0
*Great Whernside		0	49	——	. . .		0
——		1	2	——	4·1	H.	6
Ingleborough		2	8	——	68·3		3
Shunnor Fell		2	56	——	46·1		6

At the Bear's Head.

June 26, 1828. A cold, clear, blustry afternoon. Height of eye 4 feet.

				Feet.		
Ten End	40′	0″	depr.	98·8	L.	11″
Whaw Fell	24	55	——	182·4		15
Bakestone Edge	13	22	——	96·4		4
High Fleak	22	32	——	209·0		5
Pickington Ridge	15	38	——	164·7		9
WhitfieldHill, *Wall top*	36	52	——	677·2		1
Addlebrough	66	36	——	452·1		3
Penhill, *Cam top*	17	5	——	202·7		4
Harlen Fell	21	1	——	254·6		3
Stake Fell	28	7	——	175·2		4
Wasset Fell	15	54	——	140·6		2
Brownhaw	12	3	——	113·1		10
Little Whernside	6	53	——	41·1		4
Great Haw	16	45	——	234·2		1
Shunnor Fell	29	12	elev.	. . .		10
——	29	19	——	333·8	H.	2
Ingleborough	16	6	——	. . .		5
——	16	17	——	354·5		3
Lovely Seat	22	11	——	196·0		2
The Sayls	12	10	——	172·8		1
Pillar Hill	14	45	——	244·7		3
Swarth Fell	10	58	——	219·6		1
Knoutberry Hill	20	53	——	189·8		2
Dod Fell	44	29	——	175·9		4
Yockenthwaite Moor	12	32	——	93·7		3
Settronside, *Wall top*	22	32	——	289·1		2
Wildboar Fell	15	16	——	316·2		4

† It is very probable that a rock had been mistaken for the signal.

At Shunnor Fell.

June 27, 1828. Excessively sultry, calm and hazy.

Height of eye 4 feet.

			Feet.	
Pillar Hill	23′ 56″	depr.	91·0	L. 6″
The Sayls	43 13	——	161·0	14
Swarth Fell	15 36	——	115·6	10
Wildboar Fell	5 34	——	25·8	5
Lovely Seat	39 31	——	135·2	6
Bakestone Edge	58 53	——	. . .	7
————	58 43	——	431·8	12
Bear's Head	35 29	——	336·9	2
Settronside, *Wall top*	7 41	——	48·5	10
Pickington Ridge	39 12	——	501·6	9
Water Crag	18 19	——	159·6	7
Knoutberry Hill	15 56	——	143·5	1
Dod Fell	16 37	——	162·3	1
Hugh Seat †	5 44	——	. . .	6

At Bakestone Edge.

June 30, 1828. Very hazy, with a hot sun and a cloudless sky; frosty in the evening.—Height of eye 4·5 feet.

			Feet.	
Ten End	3′ 30″	depr.	5·0	L. 3″
Stake Fell	10 55	——	79·2	4
Pickington Ridge	12 20	——	66·9	9
High Fleak	39 56	——	114·2	
Penhill, *Cam top*	11 27	——	105·5	6
Little Whernside	1 52	——	59·1	H. 6
Bear's Head	7 57	elev.	96·8	4
Lovely Seat	64 55	——	293·2	1
Shunnor Fell	53 9	——	426·1	5
Water Crag	25 10	——	265·1	4
Settronside, *Wall top*	20 33	——	384·5	3
Yockenthwaite Moor	10 51	——	188·8	1
Great Whernside	12 42	——	385·4	1

At Penhill Cam.

July 1, 1828. A sultry, misty morning succeeded by a clear but rather blustry evening.

Height of the eye above the Cam top 4 feet.

			Feet.	
Harlen Fell	30′ 40″	depr.	51·9	L. 2″
Great Haw	6 36	——	31·0	0

† Miscalled Cotterfell in the last survey.

Addlebrough

			Feet.	
Addlebrough	30′ 58″	depr.	253·7	L. 3″
High Fleak	3 48	——	7·6	4
Caldberg Moor	66 11	——	447·8	5
Stake Fell	0 0	——	25·5	H. 2
Settronside, *Wall top*	45 46	elev.	. . .	1
	45 50	——	488·2	6
Great Whernside	37 43	——	494·2	5
Wasset Fell	5 51	——	56·9	13
Brown Haw	11 16	——	93·7	4
Little Whernside	18 40	——	170·2	10
Bear's Head	8 37	——	199·6	13
Pickington Ridge	1 44	——	41·2	3
Bakestone Edge	4 2	——	105·0	2
Yockenthwaite Moor	18 50	——	293·4	5
Lovely Seat	18 23	——	399·7	6
Shunnor Fell	20 2	——	534·3	2
Dod Fell	15 11	——	377·7	3
Pen-y-gent, *Wall top*	15 11	——	471·1	5

At Ingleborough.

June 14th and 18th, 1822.—Height of eye 4 feet.

			Feet.	
Great Whernside	9′ 0″	depr.	65·6	L.
Shunnor Fell	7 10	——	24·4	

At Whernside.

July 4th and 6th, 1827.—Height of eye 4 feet.

			Feet.	
Ingleborough	8′ 47″	depr.	42·6	L.
Shunnor Fell	8 27	——	67·3	

At Knoutberry Hill†.

July 5th, 1827.—Height of eye 4 feet.

			Feet.	
Ingleborough	9′ 34″	elev.	167·	H.
Shunnor Fell	9 25	——	141·3	
Great Whernside	1 55	depr.	100·7	

At Pen-y-gent Wall.

July 11th, 1827.—Height of the eye above the wall 9 inches.

			Feet.	
Ingleborough	7′ 8″	elev.	89·3	H.
Shunnor Fell	2 52	depr.	65·1	
Great Whernside	2 23	——	24·2	
Penhill, *Cam top*	26 43	——	474·5	L.

† In the last survey *for* Noughtberry Hill *read* Knoutberry Hill.

At Dod Fell.

August 25th, 1827.—Height of eye 4 feet.

			Feet.
Penhill, *Cam top*	24′ 35″	depr.	370·5 L.
Ingleborough	9 50	elev.	180·4 H.
Shunnor Fell	9 41	——	160·3
Great Whernside	1 40	——	118·4

At Whaw Fell.

September 15th, 1824, and March 29th, 1825.
Height of eye 3·5 feet.

			Feet.
Ingleborough	46′ 17″	elev.	536·3 H.
Shunnor Fell	35 29	——	512·0
Bear's Head	19 57	——	183·1

At Great Whernside.

April 15th, 1822.
Height of the eye above the loftiest rock 1 foot.

			Feet.
Swarth Fell†	10′ 7″	depr.	70·5 L.
Penhill Beacon	50 19	——	635·4

Calculation of the *mean* Differences of Level and Heights of the Stations.

Ingleborough above *Great Whernside.*

		Feet.
By Obs. at	Ingleborough	65·6
	Settronside	64·2
	Knoutberry Hill	67·0
	Pen-y-gent	65·1
	Dod Fell	62·0
Corrected mean		—64·6
Height of Ingleborough		2374·6
——	Great Whernside	2310·0

Shunnor Fell above *Great Whernside.*

		Feet.
By Obs. at	Settronside	42·0
	Bakestone Edge	40·7
	Penhill	40·1
	Ingleborough	41·2
	Knoutberry Hill	40·6
	Pen-y-gent	40·9
	Dod Fell	41·9
Corrected mean		+41·1
Height of Great Whernside		2310·0
——	Shunnor Fell	2351·1

Ingleborough above *Shunnor Fell.*

		Feet.
By Obs. at	Settronside	22·2
	Bear's Head	20·7
	Whernside	24·7
	Knoutberry Hill	26·4
	Pen-y-gent	24·2
	Dod Fell	20·1
	Whaw Fell	24·3
	Ingleborough	24·4
Corrected mean		—23·3
Height of Ingleborough		2374·6
——	Shunnor Fell	2351·3
Do. compared with Great Whernside		2351·2
	Mean	2351·3

† The observation was made six years previous to the erection of the signal.

Shunnor

Shunnor Fell above *Settronside Wall.*

		Feet.
By Obs. at	Bear's Head	44·7
	Shunnor Fell & Settronside	47·3
	Bakestone Edge	41·6
	Penhill	46·1
Corrected mean		—44·7
Height of Shunnor Fell		2351·3
——— Settronside Wall		2306·6

Ingleborough above *Settronside Wall.*

By Obs. at	Settronside	68·3
	Bear's Head	65·4
	ShunnorFell & Ingleborough	72·9
Corrected mean		—68·6
Height of Ingleborough		2374·6
——— Settronside Wall		2306·0

Great Whernside above *Settronside Wall.*

By Obs. at	Settronside	4·1
	Bakestone Edge	0·9
	Penhill	6·0
Corrected mean		—4·2
Height of Great Whernside		2310·0
——— Settronside Wall		2305·8
Do. compared with Inglebro'		2306·0
——— ——— ShunnorFell		2306·6
Mean		2306·1
Height of Wall above ground		—1·6
——— Summit of Settronside		2304·5

Ingleborough above *Bear's Head.*

By Obs. at	Settronside	355·6
	Bear's Head	354·5
	Shunnor Fell & Inglebro'	361·3
	Whaw Fell	353·2
Corrected mean		—355·4
Height of Ingleborough		2374·6
——— Bear's Head		2019·2

Shunnor Fell above *Bear's Head.*

By Obs. at	Settronside	333·4
	Bear'sHead & ShunnorFell	335·3
	Bakestone Edge	329·3
	Penhill	334·7
	Whaw Fell	328·9
Corrected mean		—332·0
Height of Shunnor Fell		2351·3
——— Bear's Head		2019·3

Great Whernside above *Bear's Head.*

		Feet.
By Obs. at	Settronside	291·4
	Bakestone Edge	288·6
	Penhill	294·6
Corrected mean		—291·9
Height of Great Whernside		2310·0
——— Bear's Head		2018·1

Settronside above *Bear's Head.*

By Obs. at	Settronside & Bear's Head	288·2
	Shunnor Fell	288·4
	Bakestone Edge	287·7
	Penhill	288·6
Corrected mean		—288·2
Height of Settronside Wall		2306·1
——— Bear's Head		2017·9
Do. compared with Great Whernside		2018·1
——— ——— Shunnor Fell		2019·3
——— ——— Ingleborough		2019·2
Mean		2018·6

Ingleborough above *Penhill Cam.*

By Obs. at	Settronside	557·3
	Bear's Head	557·2
	Pen-y-gent	563·8
	Dod Fell	550·9
Corrected mean		—556·8
Height of Ingleborough		2374·6
——— Penhill Cam		1817·8

Shunnor Fell above *Penhill Cam.*

By Obs. at	Settronside	535·1
	Bear's Head	536·5
	Bakestone Edge	531·6
	Penhill	534·3
	Pen-y-gent	539.6
	Dod Fell	530·8
Corrected mean		—534·6
Height of Shunnor Fell		2351·3
——— Penhill Cam		1816·7

Great Whernside above *Penhill Cam.*

By Obs. at	Settronside	493·1
	Bakestone Edge	490·9
	Penhill	494·2
	Pen-y-gent	498·7
	Dod Fell	488·9
Corrected mean		—492·9
Height of Great Whernside		2310·0
——— Penhill Cam		1817·1

Settronside

Settronside Wall above *Penhill Cam.*

	Feet.
By Obs. at Penhill and Settronside	488·6
By Obs. at Bear's Head	491·8
By Obs. at Bakestone Edge	490·0
Corrected mean	—489·8
Height of Settronside Wall	2306·1
——— Penhill Cam	1816·3

Bear's Head above *Penhill Cam.*

By Obs. at Settronside	201·7
By Obs. at Bear's Head and Penhill	201·1
By Obs. at Bakestone Edge	202·3
Corrected mean	—201·7
Height of Bear's Head	2018·6
——— Penhill Cam	1816·9
Do. compared with Inglebro'	1817·8
——— Gt Whernside	1817·1
——— Shunnor Fell	1816·7
——— Settronside	1816·3
Mean	1817·0

The top of the Cam is about level with the highest point of Penhill.

Ingleborough above *Bakestone Edge.*

By Obs. at Settronside	447·6
By Obs. at Bear's Head	450·9
By Obs. at Shunnor Fell and Inglebro'	456·2
Corrected mean	—451·1
Height of Ingleborough	2374·6
——— Bakestone Edge	1923·5

Great Whernside above *Bakestone Edge.*

By Obs. at Settronside	383·4
By Obs. at Bakestone Edge	385·4
By Obs. at Penhill	389·2
Corrected mean	—386·6
Height of Gt Whernside	2310·0
——— Bakestone Edge	1923·4

Shunnor Fell above *Bakestone Edge.*

	Feet.
By Obs. at Settronside	425·4
By Obs. at Bear's Head	430·2
By Obs. at Shunnor Fell & Bakestone Edge	429·0
By Obs. at Penhill	429·3
Corrected mean	—428·9
Height of Shunnor Fell	2351·3
——— Bakestone Edge	1922·4

Bakestone Edge above *Penhill Cam.*

By Obs. at Settronside	109·7
By Obs. at Bear's Head	106·3
By Obs. at Penhill and Bakestone Edge	105·2
Corrected mean	+107·0
Height of Penhill Cam	1817·0
——— Bakestone Edge	1924·0

Settronside Wall above *Bakestone Edge.*

By Obs. at Settronside and Bakestone Edge	381·9
By Obs. at Bear's Head	385·5
By Obs. at Shunnor Fell	383·3
By Obs. at Penhill	383·2
Corrected mean	—383·6
Height of Settronside Wall	2306·1
——— Bakestone Edge	1922·5

Bear's Head above *Bakestone Edge.*

By Obs. at Settronside	92·0
By Obs. at Bear's Head & Bakestone Edge	96·6
By Obs. at Shunnor Fell	94·9
By Obs. at Penhill	94·6
Corrected mean	—95·0
Height of Bear's Head	2018·6
——— Bakestone Edge	1923·6
Do. compared with Penhill	1924·0
——— Inglebro'	1923·5
——— Gt Whernside	1923·4
——— Shunnor	1922·4
——— Settronside	1922·5
Mean	1923·2

In the following Table are given, for every hill, its height as determined from the stations at the head of the column; the claims to accuracy of the different values of the altitude being considered in the calculation of the *mean* (contained in the last column), to be *reciprocally* as the distance of the station to the hill.

Hills.	STATIONS.						Mean Heights.
	Bear's Head.	Shunnor Fell.	Settronside.	Bakestone Edge.	Penhill.	Great Whernside.	
							Feet.
Pillar Hill	2263·3	2260·3	.....	.....	.....	.....	2261·0
The Sayls	2191·4	2190·3	.....	.....	.....	.....	2190·6
Swarth Fell	2238·2	2235·7	.....	.....	.....	2239·5	2237·0
Lovely Seat	2214·6	2216·1	2218·2	2216·4	2216·7	.....	2216·1
High Fleak	1809·6	.....	.....	1809·0	1809·4	.....	1809·3
Pickington Ridge	1853·9	1849·7	.....	1856·3	1858·2	.....	1855·2
Whitfield Hill, *Wall*	1341·4	.....	1357·8	.....	.....	.....	1350·5
Caldberg Moor	.....	.....	.....	.....	1369·2	.....	1369·2
Rover Crag	.....	.....	1551·8	.....	.....	.....	1551·8
Great Haw	1784·4	.....	1787·3	.....	1786·0	.....	1786·1
Little Whernside	1977·5	.....	1988·0	1982·3	1987·2	.....	1985·4
Brownhaw	1905·5	.....	.....	.....	1910·7	.....	1909·3
Harlen	1764·0	.....	.....	.....	1765·1	.....	1765·0
Penhill Beacon	.....	.....	.....	.....	.....	1674·6	1674·6
Wasset Fell	1878·0	.....	1876·4	.....	1873·9	.....	1876·0
Yockenthwaite Moor	2112·3	.....	2110·9	2112·0	2110·4	.....	2111·4
Stake Fell	1843·4	.....	1842·9	1844·0	1842·5	.....	1843·2
Addlebrough	1566·5	.....	.....	.....	1563·3	.....	1565·1
Ten End	1919·8	.....	.....	1918·2	.....	.....	1919·5
Mean error	−1·1	−1·6	+1·8	−0·3	0·0	+2·5	

Reciprocal observations by the four-inch theodolite gave 185·4 feet for the height of Rover Crag above Caldberg Moor, whence we get (1551·8 − 185·4 =) 1366·4 for the altitude of the latter; or 2·8 feet less than by the measurement from Penhill. The height of the Moor, as determined at Settronside (1359·4) is rejected because the signal could not be satisfactorily identified.

The wall on Whitfield Hill being about $5\frac{1}{2}$ feet high, we have 1345·4 feet for the altitude of the ground at the summit.

My next will contain a few barometrical measurements and geological notes made in Wensleydale and the Yorkshire portion of Lunedale.

Leeds, April 2, 1829. JOHN NIXON.

LXV. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

AT a late meeting, a paper was read, entitled "Astronomical Observations made in the Observatory at Paramatta," by Charles L. Rümker, Esq., communicated by the President.—The object of this memoir is the determination of the right ascension of two circumpolar stars of the southern hemisphere, by a direct comparison with the sun, independent of the transit, and of the solar tables. This comparison is made by deducing the superior and inferior culminations of the stars from an uninterrupted series of equal altitude, for the space of a month about the time of the equinox. This gives the difference of right ascension between the sun and stars. Finally, the distance of the sun from the equinoctial point is derived from the observed declination of the sun on those days. In an appendix, the author subjoins a list of the stars of which he ascertained the right ascensions by equal and absolute altitudes.

April 30.—Two papers were read: the first "On the respiration of birds," by Messrs. Allen and Pepys; the second, "On the spontaneous purification of Thames-water," by John Bostock, M.D. F.R.S. &c.

In the report which the author made of the result of his examination of Thames-water to the commissioners appointed by His Majesty to inquire into the supply of water for the metropolis, one of the specimens, taken near the King's Scholars' Pond sewer, was described as in a state of extreme impurity. This water had remained in the laboratory unattended to; and after an interval of some weeks, it was observed to have become clear, while nearly the whole of the former sediment had risen to the surface, forming a stratum of half an inch in thickness, and still emitting a very offensive odour. In process of time this scum separated into large masses or flakes, with minute air-bubbles attached to them. At the end of two months longer these masses again subsided, leaving the fluid almost totally free from any visible and extraneous matter. On analysis, the water was found to contain lime, sulphuric and muriatic acids, and magnesia, in much larger quantities than in the specimens of Thames-water previously examined; the proportion of saline matter being increased fourfold. The proportion of the muriates is nearly twelve times greater; that of carbonate of lime, between two and three times; and that of sulphate of lime five and a half times greater. The water, in its foul state, had given very obvious indications of both sulphur and ammonia; but neither of these substances could be detected, after its spontaneous depuration. The source of these new saline bodies is referable to the organic substances, chiefly of an animal nature, which are so copiously deposited in the Thames. The depurating process may be denominated a species of fermentation, in which the softer and more soluble animal compounds act as the ferment, and are themselves destroyed; while the salts that are attached to them are left behind. Hence, the more foul the water, the more complete the depuration;

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and it is on this principle that the popular opinion of the peculiar fitness of Thames-water for being used at sea may be explained; its extreme impurity inducing a sufficient degree of fermentation to effect the removal of all those substances which might induce any future renewal of that process.

May 7.—Two papers were read: the first was entitled, "Experimental inquiries on the electric theories of galvanism," by William Ritchie, M.A. F.R.S.: the second, "On the composition of the chloride of barium," by Dr. Turner.

May 14.—The remainder of Dr. Turner's paper on the composition of the chloride of barium, and a paper from the pen of Dr. Spurzheim, on the organization of the brain, communicated by Mr. Chenevix were read.

GEOLOGICAL SOCIETY.

Feb. 20.—At the annual general meeting of the Society held this day, the President (Dr. Fitton) delivered the following Address from the chair:

GENTLEMEN OF THE GEOLOGICAL SOCIETY,

You have heard in the report of your Council, that the favour of the Government, through the cordial interference of the Royal Society, has conferred upon us, since our last Anniversary, the Apartments in which we have now the satisfaction of being assembled. Having had an opportunity of becoming acquainted with the sentiments of the Council of the Royal Society upon this subject, I am justified in assuring you, that the most anxious desire has been expressed and acted upon by them, to promote the welfare and advance the purposes of our Institution; and I have the satisfaction of adding, that the mark of approbation with which the Lords Commissioners of the Treasury have honoured us in this instance, is supported by similar proofs of confidence in other departments of the public service.

The best return for these marks of approbation, will be to continue to promote the researches for which we are associated; and to render as useful as possible, to those who are engaged in the study of Geology, the various sources of information afforded by the collections and papers, which the liberality of your members and other contributors has entrusted to your charge. The Council has this day informed you of the measures which it considers eligible for these purposes; and I need not remind the Fellows, that the prosperity resulting from the exertions of our predecessors can be upheld only by the continued activity of those who have leisure to assist, periodically, in the current business of our institution.

Among the members whom we have lost during the past year, we have had to regret the death of Mr. William Phillips, who had been for several years distinguished by his acquirements and publications on Mineralogy and Geology; and whose name stands very creditably prominent in the list of persons, fortunately numerous in England, who, though constantly occupied in commerce, increase their own happiness, and promote useful know-

ledge, by devoting their hours of leisure to the pursuit of Natural Science.

Mr. Phillips was the author of several papers in our Transactions, all of them containing proofs of the zeal and effect with which he pursued his inquiries. It was after the invention of Dr. Wollaston's reflective Goniometer, that his assiduity and success in the use of that beautiful instrument enabled him to produce his most valuable Crystallographic Memoirs; and the third edition of his elaborate work on Mineralogy* contains perhaps the most remarkable results ever yet produced in Crystallography, from the application of goniometric measurement, without the aid of mathematics. In our fifth volume Mr. Phillips has compared some of the strata near Dover with those of the opposite coast of France; and has proved, that the cliffs on the two sides of the English Channel, though evidently portions of strata once continuous, must always have been separated by a considerable space. He was the author likewise of several detached works, which have materially promoted the study of Mineralogy and Geology. But the service for which he principally claims the gratitude of English Geologists, is his having been the proposer of the Geological "Outlines of England and Wales;" in which his name is joined with that of the Rev. William D. Conybeare;—a book too well known to require any new commendation, and to the completion of which we all look forward with increasing interest and expectation.

You have heard, in the Annual Report, the document by which Dr. Wollaston acquainted the Society with a donation intended for the advancement of Geological research. This paper was dated on the 8th of December last: the tremulous and uncertain character of the signature too evidently testified the declining state of the writer; and in a few days afterwards†, not our Society, nor England only, but the whole scientific world had to lament his death.

In this place, and in the presence of so many to whom he was personally known, I could not trust myself to speak of Dr. Wollaston, so soon after the melancholy event which has deprived us of him, in the tone that might be suitable to a public meeting. And yet, if there ever was a man, in the estimate of whose character the feelings of private attachment might be allowed to mix themselves with scientific approbation, it was he: his personal and his intellectual qualities were so consistent; both flowing obviously from the same independence of spirit and strict love of truth; and both exhibiting such admirable simplicity and good taste.

The greater number of Dr. Wollaston's productions belong to departments of inquiry which do not come within the object of our present consideration, and are recorded in the Transactions of that distinguished body, of which for many years he was

* "An Elementary Introduction to Mineralogy, &c. 3rd edition, enlarged, with numerous Wood-cuts of Crystals."—London, 1823.

† Dr. Wollaston died on the 22nd of December 1828. He was born on the 6th of August 1766.

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one of the chief ornaments. Our own Publications cannot boast of any of his papers; but he was well acquainted with the scope of our inquiries, and for several years before his death always attended to the geological phænomena of the countries which he visited in his excursions. He became a member of our Society in 1812; was frequently upon our Council, and for some time one of our Vice-Presidents; and the interest which he took in our welfare to the last, is fully testified by his recent liberal donation, and by the suggestions with which it was accompanied.

But though Dr. Wollaston did not publish any thing on the more immediate subjects of our pursuit, his success in the cultivation of other branches of knowledge has conduced, in no small degree, to the recent advancement of Geology. The discovery of two new metals was but a part of his contributions to chemical science: and his application of Chemistry to the examination of very minute quantities, by means of the simplest apparatus, divested chemical inquiry of much of its practical difficulty, and greatly promoted the progress of Mineralogy. His Camera Lucida is an acquisition of peculiar value to the Geologist, as it enables those who are unskilled in drawing to preserve the remembrance of what they see, and gives a fidelity to sketches hardly attainable by other means. The adaptation of measurement by reflection to the purposes of Crystallography, by the invention of his Goniometer, introduced into that department of science a certainty and precision, which the most skilful observers were before unable to attain; and his paper on the distinctions of the Carbonates of Lime, Magnesia, and Iron, affords one of the most remarkable instances that can be mentioned, of the advantage arising from the union of crystallography with chemical research. He was in fact a Mineralogist of the first order,—if the power of investigating accurately the characters and composition of minerals be considered as the standard of skill.

Possessing such variety of knowledge, with the most inventive quickness and sagacity in its application to new purposes, Dr. Wollaston was at all times accessible to those whom he believed to be sincerely occupied in useful inquiry: he seemed indeed himself to delight in such communications; and his singular dexterity and neatness in experiment rendered comparatively easy to him the multiplied investigations arising from them, which to others might have been oppressive or impracticable. His penetration and correct judgement, upon subjects apparently the most remote from his own immediate pursuits, made him during many of the latter years of his life the universal arbiter on questions of scientific difficulty; and the instruction thus derived from communication with a man of his attainments, has had an effect on the progress of knowledge in this country, and on the conduct of various public undertakings,—the value of which, it would be difficult to estimate,—and the loss of which it is at present, and long will be, quite impossible to supply.

These, Gentlemen, are some of the grounds upon which the memory of Dr. Wollaston claims our gratitude and veneration, as cultivators

cultivators of natural science: but to those who have known him in private life, he has left, what is still more precious, the example of his personal character. It would be difficult to name a man who so well combined the qualities of an English gentleman and a philosopher; or whose life better deserves the eulogium given by the first of our orators to one of our most distinguished public characters; for it was marked by a constant wish and endeavour to be "useful to mankind*."

In adverting to the progress which Geological research has made during the past year in this country, I may refer to the Tabular List of our Strata, of which Mr. De la Beche has recently published a second edition†, for one of the most convenient general views of the present state of our knowledge respecting them. In the following observations I shall adopt the descending order of the Series.

A complete account of the deposits which appear on the coast of Suffolk, and other parts of the eastern shores of England, especially of that which has been denominated CRAG, is still a desideratum of importance in the history of our strata. The publications of Mr. Robberds‡ and Mr. R. C. Taylor§ have given some information of considerable value upon this tract: but a general account of it, combining the local phænomena with those of analogous deposits in other quarters, is still to be wished for; and from the connexion of the facts which our eastern shores exhibit, with some of the great questions touching the true theory of the diluvial accumulations, an acquaintance with them is almost necessary to the removal of some of the numerous difficulties which still attend that subject.

Mr. Webster has announced a new work upon the Isle of Wight; in which, under the simple form of a guide to that most interesting island, he proposes to illustrate fully its Topography and Geology; particularly the relations of the strata immediately above the chalk.

The true order of the beds between the chalk and the oolitic series, which has been the subject of much recent inquiry and discussion, appears now to be generally recognized; and considerable light has been thrown upon that remarkable group, united principally by zoological relations (for, mineralogically, its members are sufficiently distinct), which occurs between the lowest of the beds denominated green-sand, and the oolite of Portland. The succession, though the beds are not continuous, has been shown to be uniform throughout England, from Norfolk southwards,—and to be the same in fact with that long since enounced, though with much variation of nomenclature, by Mr. William Smith, in his Geological Maps of the English Counties.

* Fox's speech on the death of the Duke of Bedford, 1802.

† "A Tabular and Proportional View of the Superior, Supermedial, and Medial (Tertiary and Secondary) Rocks: 2nd edition, considerably enlarged," by H. T. De la Beche, Esq. F.R.S. G.S. &c. London, 1828; Treuttel and Co.

‡ "Geological and Historical Observations on the Eastern Valleys of Norfolk," by J. W. Robberds, Jun. Norwich, 1826.

§ "On the Geology of East Norfolk," &c. 8vo. 1827; by R. C. Taylor, F.G.S.

A full

A full and elaborate Catalogue of the Fossils of Sussex has been contributed by Mr. Mantell; whose labours as a Geologist, amidst the duties of an arduous profession, have long been so useful to the public, and so honourable to himself.—This valuable paper will be published in the next portion of our Transactions. Mr. Martin of Pulborough in Sussex, another member of the same profession, has published a detached Memoir, the developement of a paper read here during the last session*; which, besides an account of the stratification in his own neighbourhood, contains much ingenious speculation on the phænomena which seem to have attended the elevation of the tract beneath the chalk, within the denudation of Sussex, Hampshire, Surrey, and Kent.

The accessions to our knowledge respecting the oolitic series, from the Portland strata down to the new red sandstone, have also been considerable during the past year. Mr. Lonsdale, I am happy to say, has presented us with an account of his researches on that important tract in the centre of England, included between the chalk near Calne and the vicinity of Bath; the maps relating to which I had the pleasure of laying before you at the last Anniversary. This valuable work, one of the most accurate perhaps yet produced in this country, may be considered as a more advanced stage of the inquiries respecting the oolitic tracts, begun so ably by Mr. Smith, and continued in Mr. Conybeare's Outlines: and it carries on the transverse section of England, from the vicinity of Bristol; which had already been illustrated by Mr. Conybeare and Dr. Buckland, in their admirable Memoir published in the first part of our Second Series.

The work upon the Coast of Yorkshire, announced by Mr. Phillips of the York Institution †, will throw light upon a still lower portion of our Oolites, and elucidate especially that remarkable group of strata which includes a series of coal-measures in connection with the lower oolite. It is very much to be desired that all our coasts were thus examined and distinctly represented; such illustration being valuable, not only in topographical history, but as affording the best evidence as to the succession of our strata, and the greatest facility to the study of them, both by foreigners and our own countrymen.

The complex and important groups which intervene between the Oolites and the Transition rocks, have been illustrated during the past year by Professor Sedgwick,—separately in England, and conjointly with Mr. Murchison, in the Isle of Arran and the north of Scotland.

Mr. Sedgwick's Memoir on the magnesian limestone, and the lower part of the new red sandstone, in the north of England, is unquestionably one of the most valuable contributions we have hitherto received; not only supplying a desideratum of the greatest

* "A Geological Memoir on a part of Western Sussex," &c. by P. I. Martin: 4to. London, 1828. [See Phil. Mag. and Annals, N.S. vol. iv. p. 38; and present volume, p. 111.—Edit.]

† This work has been published since this paper was put to the press, and fully justifies the expectations entertained respecting it.

interest

interest in our local Geology, but placing in a just light the difficult and obscure relations of that extensive series of beds which it describes. Nothing is now wanting, but the acquisition of good maps by the extension of the Ordnance Survey, to complete our geological acquaintance with the large portion of England described in this Memoir.

In Mr. Sedgwick's paper, the new red sandstone is considered as constituting one great complex formation, between the lias and the coal-measures, with two calcareous formations subordinate to it; one (the muschel-kalkstein,) in the upper part, which has not yet been discovered in our country; the other (the magnesian limestone,) in the lower part, which the author has made especially the object of his researches.

But although the Muschel-kalkstein has not yet been observed, and probably may not exist in any considerable force in England, it would be premature to assert that its equivalent may not still be detected among our strata; and this, with other circumstances, renders a good monograph of the new red sandstone formation, in the central and southern counties, a desideratum of importance. The general boundaries of the formation have been correctly traced; but the internal details remain to be investigated: and, besides the necessity of searching in the upper part of the formation for the equivalent of those beds which are so conspicuous on the continent, the relations of the porphyritic masses of Devonshire and other places (which, it is remarkable, are found in combination with the saliferous red sandstone, not only in various parts of Europe, but even in India*) are still very obscure. The publications of M. Charbaut†, M. Elie de Beaumont‡, and Messrs. Oeynhausen, Dechen, and De la Roche§ will be found to assist materially in these investigations.

The Magnesian limestone itself, according to Mr. Sedgwick, admits of natural subdivision into five groups, which, in a descending order are:—1. A series of red sandstone and marl, superior to the dolomites, and subdivided into two portions, the equivalents of the *keuper* and the *bunter-sandstein*.—2. Limestones, containing magnesia and beds of dolomite, unequally diffused, but in much less proportion than in the lower parts of the series.—3. Red marl and gypsum, comparatively of small extent.—4. The great central deposit of yellow limestone, exhibiting various modifications of dolomite, frequently concretional, in some cases oolitic; all of which apparently result from *internal* change of structure, subsequent to the mechanical deposition of the mass. These last formations (4, 3, and 2,) represent the *Rauchwacke*, *Asche*, and foliated *Stinkstein*, the breccias, and gypsum of the Thuringerwald.—5. Variegated marls, with

* Geological Transactions, Second Series, vol. i. page 160.

† "Environs de Lons le Saunier."—Annales des Mines, 1819, V. 579.

‡ "Observations sur quelques Terrains secondaires du Systême des Vosges:" Paris, 1828: also published in the Annales des Mines for 1827.

§ "Geognostische Umrisse den Rheinländer, zwischen Basil and Maintz:" 2 vols. 1825.

irregular

irregular beds of compact limestone, *Zechstein*. This formation is not co-extensive with the yellow limestone, but its place is constant; and its subordinate marl-slate is particularly distinguished by its Fossils; among which are impressions of ferns, and the remains of fishes, some of them identical with those of the copper-slate of Thuringia. —6. And lastly, an extensive deposit of coarse siliceous sandstone (*rothe-todte-liegende*,) of very unequal thickness; the upper beds of which are sometimes unconformable to the limestones which rest upon them.

It is satisfactory therefore to find, that the great mass of strata, from the oolites down to the coal, admits precisely of the same subdivisions in the north of England, as upon the continent. And with respect to the theory of these magnesian formations, Mr. Sedgwick ascribes their production to the mechanical destruction of rocks of the carboniferous order; stating however two facts, as yet imperfectly explained;—1st. The greater abundance of magnesia in the limestone formation, than could have been derived from the dolomites of the carboniferous order; and, 2ndly, The larger proportion of magnesia in some of the beds, than is found in the true dolomites; an excess which M. Elie de Beaumont has shown to exist also in the corresponding strata of the Vosges.

The want of conformity between the superior members of our series and the coal-measures, forms, it is well known, a prominent feature in the structure of the west of England:—which, besides its great importance to the coal-miner, has been supposed to mark an epoch in the order and circumstances of deposition; since a similar want of conformity exists in the north-west of France and Belgium,—and from recent observation has been found also on the flanks of the Vosges mountains*; where the shafts for obtaining coal are frequently cut through the superior beds, to reach the unconformable strata beneath. It was a question therefore, of considerable interest, to determine how far this want of conformity might extend: and Messrs. Sedgwick and Murchison have shown that in Scotland, especially on the shores of the Isle of Arran, where a very distinct section is disclosed, the coal-measures are *conformable* in position to the incumbent strata; and that a gradual transition may be observed in ascending, from the old red sandstone, to the carboniferous series with plants of the same species as of the English coal-measures; from which again there is a gradation into a series of conformable strata, supposed to be identical with the new red sandstone of England. Hence it is not improbable that more extended inquiry will prove the conformable arrangement to be the more general one; and that the want of it, within the tracts above mentioned, is accidental, and comparatively of small extent.

The researches of Professor Sedgwick and Mr. Murchison in Scotland, contained in papers one of which has been already published, throw much light upon the relations of the lower part of our series to the crystalline masses beneath; and confirm the general diffusion in that country of our secondary strata;—though in

* Ann. des Mines, 1827, i. 431.

detached portions, and generally accompanied by indications of disturbance, obviously proceeding from the primary masses on which they at present repose. It would exceed the limits to which I am here confined, to detail the results of which these memoirs give an account: the general inferences are,—1. The identity with the secondary rocks of England, of the strata in the Western-Islands, and throughout a large portion both of the east and west coasts of Scotland, is established on the evidence of fossils.—2. A formation of red sandstone has been observed, on the shores of the Pentland Firth, which appears to occupy a place between the coal-measures and the new red conglomerates.—3. A great deposit of sandstone, with subordinate beds of dark bituminous limestone, occupying, apparently, the place of the coal-formation, has been designated,—but not yet perfectly identified with any formation hitherto described. The great thickness of this deposit and the ancient character of the rocks subordinate to it, prevent its reference to the German copper-slate: but the bituminous beds in Caithness contain impressions of fish, including two new genera, with other fossils, all resembling those of the inhabitants of fresh water.—4. The principal relations have been determined, of the conglomerates and sandstones which occur upon the north-west coasts, and the north-east of the Highlands, and range along the southern flank of the Grampian chain: and this great deposit is shown to be identical with the old red sandstone of England.

The disturbance of some of the newer strata in Caithness, is referred by the authors of these papers to the elevation of the granite beneath; the amount of disturbance being in all cases nearly proportioned to the proximity of that rock: and it is rendered probable that the crystalline compound was upheaved, not in a fluid state, but after its consolidation; since, although veins are numerous in other cases of contact of granite with incumbent rocks, neither veins nor detached portions of the granite are in these instances to be met with in the shattered secondary strata which are placed upon it. There are few points more interesting to theory, than the general existence of such derangements on the confines of the primary and crystallized masses and of the stratified rocks: and this, without any other evidence, might have led to a suspicion that the former were themselves the instruments by which these dislocations were effected.

The existence in the N.W. of Scotland, of portions of strata probably deposited in freshwater, is another very interesting fact, for which we are indebted to Professor Sedgwick and Mr. Murchison: and it is particularly remarkable that the masses of limestone of this description discovered by these observers in the Isle of Skye, contain several of the same fossils (two species of cyclas, a paludina, and an ostrea) which occur also in the Weald-clay of our south-eastern counties*.

It is my office here, to mention what has been done by our contributors,

* It deserves to be mentioned, that a species of cyclas very like the medius of the weald-clay (Sowerby, Min. Conch. tab. 527. fig. 2.) and of Skye,

tributors, or by members of this Society, with a view to publication in our Transactions:—But it is proper to add, that many of the relations of the rocks of Scotland were long since investigated by Dr. MacCulloch; who in addition to his previous works has recently begun to publish, in the Journal of the Royal Institution, the results of his observations on the north and north-eastern coasts: and I myself have seen in the hands of that gentleman, some years ago, several portions of an elaborate geological map of Scotland*, of the greatest value. The labours of Professor Jameson likewise have been unremitting; and you are well acquainted with the various memoirs illustrating his native country, which he has published in the Transactions of the Wernerian Society and the other Philosophical Journals of Edinburgh.

From the situation of the capitals of England and France, at a distance from primary mountains, the study of the crystalline formations would there naturally occupy less attention than that of the stratified rocks; and with this circumstance, the extraordinary interest and novelty of recent zoological discoveries have concurred, to fix upon the newer strata,—not more attention than they deserve, but a degree of interest which has perhaps in some cases been too exclusive. The naturalist, however, who is in search of general laws, should exert himself to keep every part of his subject in view; and should never cease to remember, that, as in the study of the newer formations Zoology and Botany are his best allies,—so Mineralogy is indispensable to an acquaintance with the more ancient rocks,—and Chemistry as well as general Physics, to the solution of the problems connected with them. Mineralogy has, from various causes, been of late less vigorously pursued in England, than a few years ago; and it is probably to the previous labour which this subject requires, that we are, in part, to ascribe the comparatively backward state of our knowledge respecting the primary portions of this country. But though nothing has within the last year been published in our Transactions upon these formations, they have not been unattended to; and the Memoirs already produced, with those which are preparing for your perusal, will be found to throw great light upon the relations of our transition and primary rocks.

A Memoir by Mr. Phillips, of the York Institution, describes a tract which is a branch from the great central mass of the slaty and primary rocks of Cumberland; and gives in detail the phænomena of a district remarkable for the numerous and striking proofs which it exhibits of dislocation,—of such amount, that in one instance strata have been brought into immediate apposition, which in their original situation were separated by a thickness of more than 500 feet.

Skye, has since been discovered among the specimens brought by Captain Franklin from the N. coast of America. It was found in a loose mass of grey limestone, on the beach at the mouth of Babbage river, about 2° 30′ W. of the Mackenzie. (Dr. Richardson, in Appendix to Franklin's Second Journey. p. xxvii.—spec. 355.)

* See Edinburgh Philosophical Journal, vol. i. (1819), p. 418.

The general relations of the mountain district of Cumberland had been already briefly but correctly described by Otley *, in a tract to which I have on a former occasion referred. I am now enabled, through the kindness of Professor Sedgwick, to state the general results of his own researches in that district, the detail of which I trust will soon be laid before you. These not only correct our information respecting the Cumberland mountains, but determine some of the chief points of analogy which connect them, in structure and composition, with the primary and transition tracts of Wales and Cornwall.

In Wales, according to Professor Sedgwick, the old red sandstone seems to pass gradually into the upper members of the following series.—

1. Grauwacke, containing in its upper part organic remains, and graduating into,—

2. The great slate-formation, containing in all its parts indications of mechanical origin.

3. A vast group, differing from the ordinary character of the Welsh mountains, in containing a very large proportion of felspathose rocks of porphyritic structure. Of this, the mountains of Snowdonia are probably the lowest portion.

4. In Anglesea, Professor Henslow describes † a still lower group of slaty rocks, including chlorite and mica-slates, and quartz rock; the whole apparently dislocated by—

5. Protruding masses of granite.

In Cornwall and Devon, the well known order is—

a. Grauwacke, with calcareous beds, sometimes containing organized remains.

b. In two places, a formation of serpentine, which in the Lizard contains diallage-rock, talc-slate, hornblende- and mica-slates, appears to occur beneath the grauwacke. Its relations are obscure, but it is superior in position to the following formation.

c. The great formation of metalliferous-slate (killas); with many subordinate beds of greenstone, felspathic-slate, &c.

[There is in Cornwall no proper representative of the porphyritic formations of Snowdonia (3.)]

d. Granitic rocks, projecting veins into the incumbent slate; the granite itself being traversed by other veins of porphyry, called "Elvans."

In Cumberland, the order is as follows:—

I. The grauwacke system, containing calcareous beds with organized remains. It is unconformable to the old red sandstone, which rests upon it.

II. An enormous formation of green-slate, intimately associated with porphyry, like that of Snowdonia, and of Ben-Nevis in Scotland.

III. A formation of clay-slate.

IV. A series of crystalline schistose masses; forming the centre

* Lonsdale Magazine, for October, 1820. [Mr. Lonsdale's memoir will also be found in Phil. Mag. vol. lvi. p. 257.—Edit.]

† Transactions of the Cambridge Philosophical Society, vol. i.

of

of the Skiddaw region, and composed of chiastolite- and hornblende-slates, gneiss, &c., apparently in irregular order.

V. Granite*.

No. I, the grauwacke of Cumberland, is unquestionably the equivalent of the upper part of (*a*) the grauwacke-slate of Somerset, Devon, and Cornwall. No. II, the green-slate of Cumberland, has no representative in Cornwall; but seems to be identical with part of (No. 3) the Snowdonian formation of Wales. No. III, the clay slate, and IV, the crystalline schistose rocks, present analogies with (*c*) the metalliferous killas of Cornwall:—and on the whole, the suite of the transition and primary rocks in Cumberland assists in bringing together the phænomena of Wales and Cornwall; and in connecting the several groups in the distant parts of England, in a series of similar and probably contemporaneous formations.

The labours of the Geological Society of Cornwall are continued: and a work, of which the first volume has been published, by Mr. John Taylor, one of the principal miners in this country, promises considerable additions to a department of knowledge comparatively new to our scientific literature, but intimately connected with our pursuits. This work is entitled "Records of Mining†;" and it proposes to embrace "reports and statements upon particular mines, and the produce of metals, in various districts; notices on Geological facts relating to mining; discoveries of ores and minerals, and descriptions of existing processes connected with the treatment of ores, and the operations of smelting, or other modes of reduction; with investigations of the methods of working now usually employed in different countries, and of projected improvements; and descriptions of machinery or implements destined to the service of the mines." The editor justly adds, that many facts relating to these subjects, continually present themselves to observation, all record of which is lost, for want of a proper depository; and that not only is a quantity of valuable matter constantly occurring in the reports and statements upon our British mines, but that much more may be expected

* The mineralogical axis of all this tract extends from the centre of the Skiddaw region to the neighbourhood of Egremont. On the north of this line the formations are repeated, with the exception of No. I., which is probably buried under the unconformable old red sandstone and mountain limestone; and on this northern side, notwithstanding its less extensive developement, there is a group of mountains, almost entirely composed of diallage-rock (Euphotide) and other minerals, of which we have no trace on the south. These occupy the base of the green-slate and porphyry series, (No. 3.) of Wales; and seem to be in the exact place of (*b*.) the serpentine of the Lizard in Cornwall.

There is on the west side of Cumberland, another formation of granite and syenite, which underlies, traverses, and overlies the clay-slate, No. III., and is considered as the great centre of elevation of the region. It never overlies No. II.; but is probably connected with syenitic dykes, and other detached masses of crystalline rock, which do not belong to the ordinary rocks of superposition.

† "Records of Mining, edited by John Taylor, F.R.S., &c.," 4to. with plates. London; Murray, 1829. [See our present, vol. p. 297.—Edit.]

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to reach us from those foreign countries in which English capital is now employed.

Mr. Taylor has prefixed to this first series of tracts, a Prospectus of a School of Mines in Cornwall*; which contain suggestions well deserving the attention of those engaged in this important department of commercial speculation.

I have dwelt the longer upon that portion of our labours which refers to England, because the structure of this country is the primary object of our researches; since it is here, at home, that we can best, and in the first instance, acquire the rudiments of our subject, and gain that correctness of eye, and of judgment, which confers the right, as it were, to examine the geology of other districts,—and to claim, either from foreigners, or our own countrymen, that confidence in our accuracy, without which all attempts at comparison are vain. But in proportion as this country is known, a comparison with other regions becomes not only more interesting, but more necessary; and few, unfortunately, can be found, who, with sufficient knowledge of our subject, possess also the opportunity of travelling with geological views. In the mean time, we must be grateful for all those contributions from remote countries, which, if they do not illustrate the relations of rocks, enable us at least to answer some questions respecting their local diffusion and comparative composition,—leaving their relations and many of the phænomena of structure to future inquiry.

In the foreign Geology of Europe,—we have the gratification of knowing that the examination of France, with a view to a general map of the strata, is steadily proceeding.

We ourselves have had papers on the environs of Nice, from Mr. De la Beche and Dr. Buckland, giving a comparison of the strata in that neighbourhood with those of England, and in some cases establishing their correspondence.

The proofs of the identity of the prevailing rocks in the more distant parts of the world, are continually multiplied, by the reception of authentic specimens; for which we have been of late indebted to the Admiralty, and to British officers, in the Navy and the service of the East India Company: and the donors of every such contribution,—even of the smallest specimen, the locality of which in a distant quarter is correctly ascertained,—will have the satisfaction of feeling, that they bring us nearer to the ultimate solution of the interesting problems which are before us.

We have received from Captain Beechey, commander of the late expedition to Behring's Straits, and from Lieut. Belcher, a valuable series of specimens, collected in several detached points during the progress of that voyage: and, the notes taken by Lieut. Belcher and Mr. Colly having been put into my hands by Captain Beechey, I shall take an early opportunity of placing them before the Society. The only subject of regret relating to these papers, is their brevity; for the notes, and the sketches connected with them, would do credit to the most experienced geologists.

* See Phil. Mag. vol. lxvi. p. 137.—Edit.

A paper,

A paper, by Mr. Featherstonehaugh, read at one of our latest meetings, gives a comparison of the series of strata in the American United States, with that of England:—and various Memoirs of Dr. Bigsby, some of which have been read before this Society, contain a copious statement of facts respecting Canada and a large portion of the adjacent country.

The Memoir of Dr. Richardson, read at one of our meetings, and published in the Appendix to the account of Capt. Franklin's Second Journey, contains a most valuable series of observations, made under great disadvantages, during the advance and return of that memorable expedition to the shores of the Polar Sea; in the course of which a space of about 5000 miles was for the first time surveyed and laid down,—the total distance travelled over by the party in America being not less than 14000 miles. The great similarity of the rocks, and of their structure and external features, to those of Europe;—the uniformity in composition of vast tracts of the country;—and the very large proportion of the surface occupied by water, especially within a broad calcareous band, that intervenes between the rocky mountains and another primary tract which has nearly the same direction, are some of the more obvious general results that may be collected from the perusal of this important Memoir, a full abstract of which will be found in our Proceedings. And the whole is rendered still more interesting to us, by the liberality of the collectors, who have placed in the Museum of the Society a complete series of the specimens described and referred to by Dr. Richardson.

I have already mentioned to you the contribution of Captain King from the southern extremity of America; which demonstrates the existence there of similar rocks, exhibiting analogous appearances, to those of Europe: and we have great reason to expect, from the number and activity of the British officers and agents, whom our numerous mining projects have distributed in South America, considerable additional light on the structure and phænomena of that extensive region.

From Africa we are still without any communication, from any of the Settlements on its extensive coasts.

I am happy to say, there is every day new reason to hope for the extension of geological inquiry in India; where the liberality of the Company in carrying on the magnificent Trigonometrical Survey has already laid the best foundation for such researches. A copy of the portion of the great map which has been already published has been presented to us by the Directors; and there is every reason to suppose, that they are as much disposed to favour Geology, as they have shown themselves to be to advance the progress of astronomy and scientific topography. We owe, under this head, considerable obligation to the exertions of our own distinguished member Mr. Colebrooke, whose activity and varied information have enabled him to contribute so much, to several departments of literature and science in connexion with the East.

The Asiatic Society, also, has recently taken up the extension of geological

geological inquiry with much interest and zeal; and has opened an intercourse with India upon this subject, through Sir Alexander Johnstone, the chairman of their committee of foreign correspondence, from whence the best results may be expected. The attention of the Asiatic Society of Calcutta has of late been particularly devoted to this department of natural science; and we have, in the different Settlements, several friends and fellows of this Society, who have shown their desire to promote our views.

From Central India, Captain James Franklin has given us a Memoir on the vicinity of Bundelcund, illustrated with an excellent geological map and sections.

The papers of Dr. Buckland and Mr. Clift, connected with the splendid collection of fossil remains from the Burmese territory, with which our Museum has lately been enriched, have been published in the last part of the Transactions: and the Council has endeavoured to diffuse the information afforded by this collection, by causing models of several of the fossils to be prepared, and distributed to some of the principal museums of Natural History. The Memoir of Dr. Buckland on the specimens from Ava, has shown the probability that the representatives of no fewer than eight of our formations* exist in that region; and I shall presently refer to the interesting zoological results obtained from this splendid acquisition.

The Society has received from the Admiralty, in the course of the present session, a small collection of specimens, from the site of the intended settlement in the vicinity of Swan River, on the west coast of Australia; and Captain Stirling, before his departure from England, in the capacity of its Governor, was good enough to place in my hands some brief notes relating to them, which I shall take an early opportunity of laying before the Society. From the zeal expressed by that distinguished officer, we may regard this contribution, as an earnest of what may be expected hereafter from the colony under his superintendence: and having already received, from the eastern shores of Australia, enough to prove the resemblance of the rocks to ours, and even to point out the relative position and structure of the formations on some points of the coast, we may with reason expect the solution of some of the great questions respecting that region, which still are undetermined. It is remarkable, for example, that no traces have yet been descried, of any active volcano along the whole circuit of those shores; although the latitudes nearer to the Equator, and under nearly the same meridians, are the scenes of some of the most tremendous volcanic phænomena on record. The mode in which the waters condensed upon the vast continent of Australia are disposed of,—whether by evaporation from inland seas or lakes, or conducted to the ocean by rivers, whose existence has hitherto escaped detection, is another great question connected in all probability with its geologi-

* 1. Alluvium. 2. Diluvium. 3. Freshwater Marl. 4. London Clay and Calcaire-grossier. 5. Plastic Clay. 6. Transition limestone. 7. Grauwacke. 8. Primitive Rocks;—with indications also of the New red sandstone and Magnesian limestone.

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cal structure. But there is no subject of greater interest to us, at present, than the fossil organized remains of that country; a knowledge of which, especially of the remains of animals, will be an addition of capital importance to our subject, and probably not less valuable to the Zoologist. The diluvium, therefore, respecting which we have at present no information whatever, is deserving of the greatest attention: and,—since the existing races of Australian animals are so widely different from those of every other portion of the earth,—the identity, on the one hand, of these animals with those occurring in a fossil state, would lead to some very important inferences; while on the other, the agreement of the fossil remains of Australia with the existing races of other regions, now disjoined from that country, would give new support to some of the most popular speculations of our day. With a view to these inquiries, scarcely anything that can be collected by our fellow-labourers in that quarter, will be without interest to their friends in Europe.

The popularity which the study of Zoology continues to acquire in England, opens the brightest hopes in every department of inquiry connected with that important branch of natural history. Our papers during the past year have added to the list of fossil animals two new species of Mastodon, connecting very beautifully the structure of the teeth in the animals of that genus previously known, with that of the Elephant. And Mr. Pentland has given an account of some fossils from Bengal, presented through the kindness of Mr. Colebrooke; which include the remains of a new Anthracotherium, and appear to have been situated in a deposit resembling some of the tertiary strata of Europe.

We owe to Mr. Broderip, one of the Secretaries of our Society, a paper in the Zoological Journal*, describing the Fossil jaw of a Didelphis, found at Stonesfield, the geological situation of which had been the subject of some debate; with a statement of the evidence by which its true place in our series of strata is proved to be within the oolitic-slate beneath the Oxford-clay, probably very near the site of the forest-marble.

From Dr. Buckland we have had a description of the remains of a new species of Pterodactyle, discovered by Miss Anning in the lias at Lyme Regis. The head of the only specimen yet found is wanting; but the remainder of the skeleton warrants the distinction of it from the two species described by M. Cuvier. The length of the claws, especially, is a prominent character; from whence the author has given to this species the name of Macronyx. Mr. Miller of Bristol, several years ago, suggested that the bones found in the Stonesfield-slate ought to be ascribed to this extinct family of reptiles; and Dr. Buckland entertains the same opinion respecting certain bones found also in the lias, at Lyme-Regis, and supposed to have been those of birds. The Pterodactyles consequently, would appear to have been in existence throughout the entire interval from the deposition of the lias to that of the chalk.

* Zoological Journal, vol. iii. p. 408, &c.

The author has connected with his paper on the Pterodactyle, some observations on a substance analogous to album-græcum, produced apparently by the Saurian animals, whose remains are deposited in the lias; and on a dark colouring matter possessing the properties of Sepia and Indian ink, afforded by a fossil which exhibits a structure like that of the cuttle-fish. He is still engaged in the inquiries connected with these subjects; and has already obtained some very curious and unexpected results.

Mr. R. C. Taylor, one of our Fellows, has prepared a valuable list of the fossils hitherto discovered in the British strata*, drawn principally from the works and authority of Mr. Sowerby, to whose indefatigable exertions in extending our acquaintance with the fossils of England Geology is under most essential obligation. The List details the genera in each of its divisions alphabetically; giving for each genus the number of the species most characteristic or abundant in each formation, with the principal localities where they occur. It is not susceptible of abridgement: but some of the results which can be expressed by numbers, have been thrown by the author into Tables, of which the following is a summary:—

Stratigraphical distribution.			Simple Univalves.	Simple Bivalves.	Complex Bivalves.	Multilocular Univalves.	Total numbers.
Shells.	Recent.	Total number of Species known. (from Wood's *Index Testaceologicus*)	1961	874		58	2893
	Fossil.	Total number of Genera	58	62	3	12	135
				65			
		Total number of Species	401	583	51	230	1265
				634			
	Ancient Strata.	*Carboniferous Order*, of Conybeare. (Species)	27	34	46	33	140
		Carboniferous beds, to *Lias*. (Species)	9	33	5	50	97
		Ancient strata, to *Lias* inclusive. Total of Species	36	67	51	83	237
					134		
	More recent Strata.	*Inferior Oolite*, to *Chalk* inclusive. (Species)	106	375	0	139	620
		Strata above the *Chalk*. (Species)	259	141	0	8	408
		From the *Lias* to the most recent beds. Total of Species	365	516	0	147	1028
					147		

It appears therefore, that the total number of known existing species being about 3000, the number of fossil species is about 1300.

* Now published in Loudon's Magazine of Natural History, for March 1829, Vol. II. p. 26, &c.

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And the author states, among other inferences from his Tables, that the ancient period is characterized by the complex shells, the middle by bivalves, the upper strata by the simple univalves; while, as we descend in the series of strata, we recede from the existing forms and proportions of numbers; 134 complex species out of 237 being found in the ancient beds, and only 147 out of 1028 in the more recent. These numbers, it will be observed, are connected with the system of Linnæus, and will probably be found to differ considerably from an enumeration according to the method of Lamarck: and the time perhaps is still remote, when any such comparison of numbers can be expected to come near the truth. The proportion of the known species to the total number, either of the existing or the fossil shells, is the result of circumstances in a great measure accidental,—the industry or success of collectors, and the greater or less extent to which the contents of the conchiferous strata are brought to light by human labour, or naturally disclosed: and all these sources of inequality must for a long time affect the different strata so unequally, that any general inferences now derived from the enumeration of species must be received with considerable qualification.

The Council has mentioned to you the late addition to the Museum, of a splendid series of casts of fossil remains, presented by the Baron Cuvier, and doubly valuable from their connexion with his own publications. These, in fact, are but continued proofs of the interest which that illustrious naturalist has always taken in the progress of this Society; and few of us have ever visited the French capital, without partaking, in person, of his hospitality, and deriving advantage from his aid in our inquiries. When the state of knowledge which many of us can remember, is contrasted with what we know at present respecting fossil organized remains,—now that we have acquired the power of determining from a single bone, or even a fragment, almost the entire structure and relations of animals, whose races are no longer in existence;—and when we recollect, that we owe to the same person the most complete history of fossil remains that has ever yet appeared, in richness of matter, in arrangement, and in style; and that all this is but a part of what one man has already performed,—we cannot be surprised at the eminence which he occupies in public opinion. The name of Cuvier is in fact identified with our subject; for, unquestionably, to no one now living is Geology so much indebted as to him: and he enjoys the enviable good fortune, not only of receiving from every side the tribute of admiration and gratitude arising from his works, but of witnessing himself the influence which they have shed, and are every day producing, on all the kindred departments of science, and in almost every quarter of the globe.

On the subject of Fossil Plants, we have heard, during the last session, a valuable paper; and there are, at present, before the Society, several new specimens, which it is intended to figure and describe without delay. The number of such specimens, in detached private collections throughout this country, we know to be so great,

that when the wish of the Council to assist in describing and publishing them is generally known, we shall probably never want such a supply, as will enable us to connect with every future part of our Transactions some contribution to fossil Botany. Great benefit will thus be produced, by circulating information at present locked up and unavailing; and the specimens lent to the Society for illustration, will be rendered doubly valuable to the proprietors themselves.

The Botanical paper, in the last part of our Transactions, is that of Dr. Buckland, on the *Cycadeoideæ;* a new family of fossil plants, discovered in the isle of Portland, and obtained most probably from a stratum immediately above the oolitic beds, which contains also lignite, with the silicified trunks of dicotyledonous trees.

On the suggestion of Mr. Brown, these fossils have been considered as belonging to a family very nearly related to, but perhaps sufficiently distinct from, the recent Cycadeæ: and the observations of this distinguished Botanist, with respect to the stem or caudex of this family, are illustrated by sections represented in the plates which accompany Dr. Buckland's paper.

The family of Cycadeæ consists at present of two genera, Zamia and Cycas. In certain Zamiæ, Mr. Brown states, there is one narrow vascular circle, divisible into radiating plates, and situated in the midst of the cellular substance of which the stem is in a great part composed. In Cycas revoluta, a second circle is added externally, at a small distance from the first; and in Cycas circinalis, (according to the only section of this plant yet published,) the circles are more numerous,—the outermost being still considerably removed from the circumference.

The fossil stems, which are the immediate subject of Dr. Buckland's paper, like the recent Cycadeæ, are not covered with true bark, but have a thick case, made up of the basis of decayed leaves, which externally form rhomboidal compartments, similar to those of the recent plants. The internal structure in the fossils, so far as hitherto examined, resembles that of the Cycadeæ, except in the more external position and greater breadth of the circle or circles visible in the section of the stem; a character whereby, Mr. Brown is of opinion, this fossil family approaches more nearly, than the Cycadeæ, to the ordinary structure of dicotyledonous woods; and consequently may be considered as supplying, from the fossil world, a link, which helps, in some degree, to connect the still distant structure of the Cycadeæ with that of the nearest existing family, the Coniferæ.

M. Adolphe Brongniart's publications on the History of Fossil Vegetables*, though produced in another country, are too important to our inquiries not to be mentioned here. Some fear, perhaps, may be entertained, that his data are not yet sufficiently

* "Prodrome d'une Histoire des Végétaux Fossiles;" published also as the article "Végétaux Fossiles," in the Dictionnaire des Sciences Naturelles; Paris, 1828.—"Considerations Generales sur la Nature de la Végétation," &c. Ann. des Sciences Naturelles; December, 1828.—"Histoire des Végétaux Fossiles," &c., publishing in Numbers.

extensive

extensive to form an adequate base for his deductions; but there can be no question as to many of his inferences, nor respecting the impulse which the subject will receive from such an accumulation of facts as he has brought together. His views contrasting the climate of the globe at former periods and at the present time,—and his division of the epochs of geological deposition, as deduced from the study of fossil plants, in comparison with those which mere geological inquiry points out,—are most ingenious. Even if regarded as no more than the conjectures of so acute and indefatigable an inquirer, these speculations would be well deserving of attention; and altogether, his works on Fossil Plants must be considered as constituting one of the most valuable contributions to this department of Geology that has ever appeared.

We have received from our foreign members Messrs. Oeynhausen and Dechen, a paper on Ben-Nevis, the highest mountain in Scotland, which gives rise to some general reflections of great interest to theory:—And I mention this contribution with the greater pleasure, because I know that it is a peculiar gratification to the Society to receive the papers of foreigners; and that if, in any instance, our aid, either as a Society or individually, has promoted the inquiries of travellers in England, they may be assured that no return can be more acceptable to us, than the illustration of our own country by their publications, or the application of the knowledge which they have acquired here, to elucidate the corresponding tracts of the Continent.

The summit of Ben-Nevis consists of porphyry; the flanks are granite, on which again is incumbent mica-slate. Messrs Oeynhausen and Dechen have ascertained that the porphyry, instead of being an overlying mass, as has been asserted in similar cases, comes up *through* the granite; and that, as veins shooting from the granite are found to penetrate the incumbent mica-slate, so veins of the porphyry shoot into the granite itself, and thus demonstrate the more recent protrusion of the former compound. It has long been known, that granite, in the Isle of Arran and at Newry in Ireland, is traversed by veins of pitchstone, which itself is only a variety of porphyry: and Mr. Knox's detection of bitumen in pitchstone of every age, as well in various other rocks of the trap formation*, coincides with this evidence, in demonstrating the igneous origin of that entire series of compounds. The light which the observations of Messrs. Oeynhausen and Dechen throw upon the "*Elvans*," or porphyritic veins of Cornwall, was alluded to in the conversation which followed the reading of their paper here; for these Elvans are in fact great veins of porphyry: and since it would be inconsistent and unphilosophical to assign the production of phænomena of the same character to different causes, the probable origin of all veins, either by injection or sublimation from below, receives from these facts new and independent support†.

* Phil. Trans.; 1822 and 1823.

† Messrs. Oeynhausen and Dechen's paper on the phænomena of veins, &c. attending the junction of the granite and the killas in Cornwall, will be found at p. 170 and 241 of the present volume.—Edit.

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The spirited publications of Mr. Scrope, especially his plates in illustration of the volcanic district of Central France, have renewed the attention of geologists in England to that country, from whence so many luminous views may be obtained on various points of theory. By placing the phænomena before the eye, Mr. Scrope has enabled his readers more easily to appreciate the merit of M. De Montlosier's admirable Essay on the Extinct Volcanoes of Auvergne*; a work published more than thirty years ago, and containing most correct inductions and forcible reasoning on the origin of valleys, but almost unknown amongst us, till its doctrines were brought under our attention in a recent paper of Messrs. Lyell and Murchison†, which confirms M. De Montlosier's views by new and interesting details. We are enabled, by this various assistance, to enter into the evidence derived from Auvergne, in support of the opinion which ascribes the origin of valleys, in many cases, to the gradual but long continued action of the streams of which they are now the channels:—a theory in fact brought forward several years before by De Saussure; to whose priority M. De Montlosier,—when conducted by other evidence, to views precisely the same,—has very candidly given his testimony‡.

I select these names from many of eminence, which might be mentioned, in connexion with this doctrine, and with the geology of Central France, because it is to De Saussure and De Montlosier that we owe the principle,—and to the beautiful drawings of Mr. Scrope, decidedly the best graphic illustration of that interesting tract. And I avail myself of this occasion to add, that De Montlosier's work affords a good example of the injury arising from our being too generally unacquainted with the publications of the continent. A few years, it is true, have materially changed the character of books upon Geology; but there is much in the topographical description of almost every country, which none of us ought to neglect. With the recent productions of France we are in general familiar; but we know much less than we ought to do, even of the

* "Essai sur la Theorie des Volcans d'Auvergne:" Riom et Clermont; 1802.—Anonymous.

† This paper will be published in the ensuing Number of Professor Jameson's Edinburgh Philosophical Journal.

‡ "Essai, &c. Chap. VI. "Des Revolutions operées par les eaux fluviatiles." The volume of De Saussure, referred to by M. De Montlosier, bears the date of 1786; the passages are in § 920; vol. i. 4to.

As M. De Montlosier's work of 1802 is stated to be only a reprint of the same publication in 1788, (Cuvier's éloge of Desmarest;—Eloges, II. p. 362,) it is the more remarkable that Mr. Playfair (whose illustrations of the Huttonian theory were first published in 1802,) does not appear to have been acquainted with it; since it cannot be doubted that he would have availed himself of such evidence, as that adduced by De Montlosier, from a series of phænomena entirely distinct from those to which he himself refers, in his sections on the proposition that "rivers have hollowed out their valleys;" which are composed with admirable force and eloquence. (Illustrations, §§ 315—329.) This coincidence, in the views of two such writers, without communication, is strongly in favour of their correctness.

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modern publications of Germany: and of those of Italy, which include a great number of tracts on topography and physical geography, full of ingenious speculation and valuable detail, there are but few indeed with which we are acquainted. The description of our own country is but a step to what Geology is yet to become; and for the generalization which is wanting to render it worthy of alliance with the higher departments of science, the study of foreign productions is not only expedient as an economy of labour and time, but is demanded by justice and truth.

Messrs. Lyell and Murchison concur with De Montlosier and Scrope, in testifying that the valleys in Auvergne and the Vivarrais have been produced by the streams, in opposition to any more general or violent agency. They regard some of the deposits of transported materials in that country, which contain organic remains, and are more recent than the tertiary formations, as having been accumulated in small lakes, caused by the temporary obstruction of rivers,—either by lavas, or by land-falls after earthquakes:—and they did not find upon the surface, even of the most ancient lava-currents, any trace of that more extensive diluvial action, nor any remnant of those masses of rock transported from great distances, which have been supposed to be of universal occurrence over the entire surface of the globe.

It is not here my province to enter into the discussion of these interesting questions, nor to pronounce an opinion upon them. It will be sufficient to have intimated, that much still remains to be done, even in this department of inquiry, the progress of which has been of late so very remarkable: and that as the doctrine of Werner, which ascribed to volcanic power an almost accidental origin, and an unimportant office, has long since expired; so the more recent views, which regard a certain class of causes as having ceased from acting, will probably give place to an opinion, that the forces from whence the present appearances have resulted, are in Geology, as in Astronomy and general Physics, permanently connected with the constitution, and structure of the Globe.

Such, Gentlemen, is a brief statement of the product of our labours during the past year, and of some of the objects which you may perhaps regard as still deserving your attention. If, on comparing our subject with some other departments of physical research, we lament that we cannot avail ourselves of such aid as mathematical science furnishes to the astronomer; if the phænomena we are occupied in observing be inferior in sublimity to those presented by the heavenly bodies, and the laws we investigate less strict than those which govern their motions,—still do our inquiries claim a very high place as an exercise of intellectual power. The geologist, like the astronomer, is called upon to trace the operation of forces, not only vast beyond conception in themselves, but acquiring almost infinite augmentation of effect, from the numberless ages during which they have been unremittingly exerted: and the problem, to explain the condition of the earth's surface at any moment of this career, is complicated as much perhaps as any

any other in physics, from the nature of the agents, of which change and irregularity appear to be essential characteristics. The degradation of the surface by the atmosphere, the erosion of streams and torrents, the encroachments of the sea, the growth and decay of the organized beings that successively inhabit the globe, with all the chemical and mechanical changes going on around us, though constantly in progress, are for ever varying in the degree of their activity. The great phænomena of volcanic agency, which seems as it were to constitute one of the vital powers of the earth, are from their very nature, transitory and erratic. Viewed, nevertheless, in relation to the vast periods of time, during which phænomena of the same kind have been continually recurring, these very accidents and apparent irregularities acquire a sort of uniformity. They intimate the repetition of results in future, resembling those which seem already to have occurred repeatedly in the history of the globe; and that part of the Huttonian theory, where the course of geological revolution has been compared to the cycles, in the movements of the heavenly bodies,—in which, after a long series of periodical deviations, the same order is sure to recur*,—seems to acquire new probability from every step of our progress, and to be really no less just, in a philosophic view, than it is captivating to the imagination. You need no incitement to persevere in such inquiries as these; your presence here is proof that you feel the attraction of them:—and if the conduct of your affairs calls off from the more seductive occupation of research, those who undertake the discharge of your official duties, they are consoled by the hope that they may have been of service to you, and by the proofs they continually receive of your confidence and indulgence. Of the value of these rewards, no one is more sensible than the person who now addresses you:—I thank you, Gentlemen, most sincerely for the kindness with which you have assisted me in the discharge of my duties as President; and, in transferring my office to the able hands by which it will be directed during the next two years, I bid you, most respectfully, Farewell.

The Meeting then proceeded to the election of the Officers and Council for the ensuing year; when the following list was delivered in by the Scrutineers: viz.

Pres.: Rev. A. Sedgwick, M.A. F.R.S. Woodwardian Prof. Camb. —*Vice-Pres.:* Rev. W. Buckland, D.D. F.R.S. Prof. Min. & Geol. Univ. Oxford; G. B. Greenough, Esq. F.R.S. L.S. & H.S.; L. Horner, Esq. F.R.S.; H. Warburton, Esq. M.P. F.R.S.—*Sec.:* W. J.

* "The Geological system of Dr. Hutton resembles, in many respects, that which appears to preside over the heavenly motions. In both, we perceive continual vicissitude and change; but confined within certain limits, and never departing far from a certain mean condition, which is such, that in the lapse of time the deviations from it on the one side must become just equal to the deviations from it on the other. In both, a provision is made for duration of unlimited extent; and the lapse of time has no effect to wear out or destroy a machine constructed with so much wisdom."—Playfair's Illustrations:—§ 387, note xx.

Broderip,

Broderip, Esq. F.R.S. L.S. & H.S.; and R. I. Murchison, Esq. F.R.S. & L.S.—*For. Sec.:* C. Lyell, Esq. M.A. F.R.S. & H.S.—*Treas.:* J. Taylor, Esq. F.R.S. & H.S.—*Council:* A. Aikin, Esq. F.L.S.; J. E. Bicheno, Esq. F.R.S. Sec. L.S.; J. Bostock, M.D. F.R.S. L.S. & H.S.; D. Burton, Esq.; Captain G. Everest, F.R.S.; M. Faraday, Esq. F.R.S.; W. H. Fitton, M.D. F.R.S. & L.S.; D. Gilbert, M.P. Pres. R.S. F.S.A. &c. &c.; J. Lindley, Esq. F.R.S. & L.S.; Rev. J. H. Randolph, M.A.; P. M. Roget, M.D. Esq. Sec. R.S. F.L.S.; N. A. Vigors, Esq. M.A. F.R.S.; N. Wallich, M.D. F.L.S.; Rev. J. Yates, M.A. F.L.S.

ASTRONOMICAL SOCIETY.

Jan. 9.—The President read an extract from a letter of Professor Encke, dated Berlin, Dec. 7, 1828, in which he stated the places of his comet, as resulting from his own observations.

A paper was next read "On the determination of the distance of a comet from the earth," by J. W. Lubbock, Esq. M.A.S. The author in this paper proposes to examine the principle of the various methods which have been proposed for the resolution of this problem,—to bring them under one notation,—and to ascertain from which the greatest advantage is to be expected.

There was also read a paper On the longitudes of Calcutta, Madras, and Futty Ghur, as determined by lunar transits and eclipses of Jupiter's first satellite, by Major J. A. Hodgson, Surveyor-General of India, accompanied with the original observations and reductions.

The last paper read was from Mr. Rumker, the astronomer at the Paramatta Observatory, detailing the observations for determining the December solstice in 1827, with one of Reichenbach's repeating circles; and likewise the observations of certain circumpolar stars, about the same period of time, by means of the mural circle. In reducing the observations for the solstice, Mr. Rumker (on account of the small zenith distance of the sun) applies a correction different from that given by M. Biot in his *Astronomie*. The result of his observations makes the mean obliquity of the ecliptic, reduced to January 1, 1828, equal to 23° 27′ 40″·01.

COLLECTION OF MINERALS ON SALE.

I beg to announce to the cultivators of mineralogical science, that the extensive and valuable collection of my late brother William Phillips is to be disposed of by private contract.

The collection consists of several thousands of specimens, selected with great care and judgement, in excellent condition; it contains most of the mineral substances at present known, and is rich in varieties of most of them. It is perhaps scarcely requisite to observe, that this collection served as the basis of the late proprietor's well known work on Mineralogy, and it is accompanied with many of the original drawings of crystals with which that work is illustrated; as well as the specimens of Uranite, Ruby Copper, and Oxide of Tin, of the crystalline forms of which detailed accounts are given in the Transactions of the Geological Society. The collection contains

not only the latest discovered mineral bodies, but abounds with specimens from Cornwall, which were not uncommon forty or fifty years since, but are now more rarely met with.—Particulars and catalogues may be had of Mr. G. B. Sowerby, 156 Regent-street.

R. Phillips.

METEOROLOGICAL OBSERVATIONS FOR APRIL 1829.

Gosport.—Numerical Results for the Month.

Barom. Max. 30·00 April 26. Wind N.E.—Min. 28·88 April 14. Wind S.W.
Range of the index 1·12.
Mean barometrical pressure for the month ..... 29·497
Spaces described by the rising and falling of the mercury..... 6·680
Greatest variation in 24 hours 0·440.—Number of changes 23.
Therm. Max. 65° April 24. Wind N.E.—Min. 31° April 1. Wind N.E.
Range 34°.—Mean temp. of exter. air 48°·68. For 30 days with ☉ in ♈ 48·03
Max. var. in 24 hours 24°·00—Mean temp. of spring-water at 8 A.M. 49°·94

De Luc's *Whalebone Hygrometer.*

Greatest humidity of the atmosphere in the evening of the 23rd ... 90°
Greatest dryness of the atmosphere in the afternoon of the 22nd 42
Range of the index..... 48
Mean at 2 P.M. 59°·3—Mean at 8 A.M. 67°9.—Mean at 8 P.M. 71·8
—— of three observations each day at 8, 2, and 8 o'clock..... 66·3
Evaporation for the month 1·60 inch.
Rain in the pluviameter near the ground 6·465 inch.
Prevailing winds, S., S.W., and N.W.

Summary of the Weather.

A clear sky, 3; fine, with various modifications of clouds, 12; an overcast sky without rain, 7; rain, 8.—Total 30 days.

Clouds.

Cirrus.	Cirrocumulus.	Cirrostratus.	Stratus.	Cumulus.	Cumulostr.	Nimbus.
27	13	30	0	22	28	27

Scale of the prevailing Winds.

N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Days.
2	3	1	3	6	6	3	6	30

General Observations.—The weather this month has been very wet, windy, and cold at the beginning and end. The April showers, or rather heavy rains mixed with hail, have been constant, and perhaps they will be found ungenial to the late sown seeds in the low lands, many thousand acres of which have often lain under water on finding its level from the higher ground in this country. Here it has rained more or less every day except three, and so heavy that the depth for April is unprecedented, and nearly four inches more than its average during the last fourteen years; but on most days sunshine and dry winds occasionally intervened. The reports from Scotland, where particular attention is paid to meteorology, of the cold, wet and windy weather, the backwardness of the spring and vegetation in general, are no better than those in the southern parts of England. In the afternoon of the 2nd instant, showers of pulpy hail with icy nuclei descended several times and slightly covered the ground; yet the aridity of the air was remarkable at these times; as a De Luc's whalebone hygrometer ranged between 40° and 50°, which is considered dry.

Solar halos on the 4th, 11th, 14th, 15th and 18th, and lunar halos in the evenings of the 13th and 15th, were constantly followed by heavy rain and strong gales of wind. The solar halo which appeared at 2 P.M. on the 15th, was 45 degrees in horizontal diameter, and was intersected at the top

top by the upper part of a semi-halo whose diameter was 59 degrees, and at the intersection the colours were extremely bright. The arcs of intersected halos are very generally reversed to each other, but these formed an exception, the exterior semi-halo having the same position as the upper part of the perfect halo, only its diameter was 14 degrees wider, which perhaps was occasioned by two strata of hazy clouds that appeared at different altitudes at the time; for had the enlarged semi-halo been caused by reflection, the arcs of both would have been parallel, the same as the iris and its reflected bow. At 10 P.M. on the 8th, a faint lunar iris appeared to the eastward in a passing *nimbus*. This is a rare meteoric phænomenon, and is generally seen at the expense of a wetting.

The effect of the strong gales from the S.E. and S.W. on the 14th, sunk the barometer unusually low; nor have we had so low a monthly mean pressure of the atmosphere since February 1823. On the 17th two swallows were observed here, being the first time of their appearance this spring.

The morning of the 24th was warm, and by noon the exterior thermometer in the shade had risen to 65 degrees, when glows of heat were felt from surrounding *cumulostratus;* but the maximum temperature of the external air on the following day was 24 degrees lower! and it being three or four degrees less than that which elicits dew from the atmosphere, a deposition of dew on the inside of the glass windows continued from 10 A.M. till 4 P.M., when the rain, sleet and large flakes of snow ceased. The temperature of the external air during that time varied from 41 degrees to 39 degrees, and of that in a room with a small fire from 50 degrees to 48 degrees; the corresponding averages being 40 degrees and 49 degrees, the mean of which, after the inosculation of the external with the internal air, is 44½ degrees for the dew or vapour point, which nearly agrees with more delicate experiments in ascertaining the degree of temperature requisite for the production of dew. The mean temperature of the air this day was 12½ degrees colder than the mean of the same day of the month for the last 14 years; and the mean temperature for the month is more than a degree under the mean of April for the same period.

The wind blew in very heavy gusts from the N.W. on the 28th, and from the N. on the 29th; and in London, Liverpool, Scotland, and Ireland, it was felt as a hurricane, where it did considerable damage.

The atmospheric and meteoric phænomena that have come within our observations this month, are one parhelion, five solar and two lunar halos, one lunar and three solar rainbows, two meteors, thunder once, and twelve gales of wind, or days on which they have prevailed; namely, one from the North, two from the North-east, two from the East, one from the South-east, three from the South, two from the South-west, and one from the North-west.

REMARKS.

London.—April 1. Fine. 2. Slight fall of snow in the morning: stormy. 3. Stormy, with slight snow-showers. 4. Cloudy: rain at night. 5—7. Showery. 8, 9. Wet. 10. Fine, with slight showers. 11. Fine: heavy rain at night. 12. Showery: stormy at night. 13. Fine morning: showery. 14. Fine: rainy in the afternoon, with a boisterous gale during the night. 15. Stormy, with showers, with a boisterous gale during the night. 16. Heavy rain: fine at night. 17. Fine, with showers. 18, 19. Fine in the morning: showery. 20. Cloudy, with showers. 21. Slight fog in morning: very fine. 22. Heavy rain. 23. Cloudy morning: fine. 24. Cloudy. 25. Stormy and wet. 26. Very fine. 27. Rainy. 28. Stormy, with showers and strong gale. 29. Stormy. 30. Cloudy.

Meteoro-

Meteorological Observations made by Mr. BOOTH at the Garden of the Horticultural Society at Chiswick, near London; by Mr. GIDDY at Penzance, Dr. BURNEY at Gosport, and Mr. VEALL at Boston.

Days of Month, 1829.	Barometer.							Thermometer.							Wind.				Evap.	Rain.			
	London.		Penzance.		Gosport.		Boston	London.		Penzance.		Gosport.		Bost.	Lond	Penz.	Gosp.	Bost.	Gosp.	Lond.	Penz.	Gosp.	Bost.
	Max.	Min.	Max.	Min.	Max.	Min.	8½ A.M.	Max.	Min.	Max.	Min.	Max.	Min.	8½ AM.									
April 1	29·523	29·367	29·65	29·55	29·45	29·40	29·10	50	29	48	39	50	31	38	NW.	NE.	N.	NW.	...	...	...	...	...
2	29·667	29·556	29·72	29·70	29·58	29·49	29·12	48	30	46	39	49	34	38	NW.	N.	NW.	W.	...	0·01	...	0·020	...
● 3	29·884	29·733	29·75	29·75	29·70	29·68	29·30	50	29	51	38	53	39	38·5	SW.	NW.	NW.	NW.	0·20	...	...	...	...
4	29·731	29·511	29·50	29·48	29·67	29·43	29·26	55	42	54	40	57	44	44	S.	SW.	S.	W.	...	·14	0·500	·360	...
5	29·392	29·246	29·25	29·17	29·34	29·17	28·92	56	42	53	42	55	45	45	SW.	SW.	S.	calm	...	·08	·380	·120	0·06
6	29·307	29·212	29·19	29·18	29·15	29·10	28·74	55	36	51	43	57	42	48	S.	W.	S.	W.	·10	·13	·200	·070	·14
7	29·369	29·200	29·35	29·30	29·30	29·16	28·74	58	30	48	39	53	40	46	S.	NW.	NW.	calm	...	·24	·250	·170	·03
8	29·450	29·420	29·36	29·35	29·36	29·34	29·00	51	37	49	39	57	44	44·5	SW.	SW.	S.	calm	...	·33	·200	·300	...
9	29·369	29·230	29·37	29·35	29·30	29·18	28·94	49	38	53	39	56	41	42	SW.	NW.	SW.	calm	·10	·30	·040	·140	·27
10	29·612	29·464	29·55	29·50	29·51	29·40	28·97	54	34	50	40	56	41	48·5	SW.	NW.	SW.	W.	...	·02	...	·020	·61
☽ 11	29·648	29·445	29·62	29·30	29·60	29·37	29·13	57	45	54	40	59	50	44	SW.	S.	S.	calm	...	·51	·640	·870	·05
12	29·253	29·139	29·15	29·05	29·19	29·09	28·75	60	47	56	46	60	48	52·5	S.	SW.	SW.	W.	·10	·14	·060	·210	·37
13	29·205	29·157	29·15	29·08	29·11	29·10	28·60	56	40	55	44	55	43	52	S.	W.	S.	W.	...	·12	...	·170	...
14	29·320	28·978	29·15	28·85	29·20	28·88	28·80	60	47	55	44	56	45	50	S.	SE.	SE.	W.	...	·31	1·225	·430	...
15	29·332	29·178	29·15	29·05	29·26	29·08	28·52	55	44	54	42	56	44	51·5	S.	SW.	SW.	W.	·10	·04	0·120	·650	·24
16	29·440	29·278	29·45	29·20	29·33	29·17	28·85	47	35	55	42	53	40	47	N.	W.	NW.	calm	...	·63	...	·280	...
17	29·806	29·672	29·70	29·58	29·73	29·57	29·15	60	45	57	45	58	46	50	SW.	W.	SW.	calm	...	.07	...	...	·39
18	29·840	29·814	29·88	29·85	29·80	29·77	29·30	61	45	56	45	60	43	52	W.	NW.	SW.	calm	·30	·17	·120	·060	·06
○ 19	29·721	29·658	29·85	29·85	29·66	29·62	29·12	54	37	52	44	56	42	49	W.	NW.	W.	W.	...	·03	·135	·180	·16
20	29·882	29·745	29·84	29·80	29·80	29·73	29·23	56	32	54	42	59	43	46	SW.	SW.	W.	W.	...	·01	...	...	...
21	29·864	29·648	29·85	29·65	29·73	29·54	29·37	60	45	57	47	58	46	50	E.	SE.	E.	SE.	·20	·05	·075	·460	...
22	29·604	29·458	29·40	29·37	29·48	29·40	29·16	47	42	59	48	60	46	45·5	E.	SW.	SE.	E.	...	·22	...	·050	...
23	29·747	29·680	29·50	29·45	29·65	29·58	29·32	60	46	54	46	58	48	46·5	NE.	SW.	SE.	calm	...	·28	·755	·410	·09
24	29·876	29·761	29·65	29·55	29·72	29·67	29·40	50	42	59	47	65	44	42	E.	SE.	NE.	E.	·10	·02	...	·515	·15
25	30·064	29·805	29·90	29·85	29·90	29·64	29·50	44	33	49	44	41	37	48	E.	NE.	NE.	E.	...	·47	·640	·850	·05
☾ 26	30·158	30·050	30·05	30·03	30·00	29·98	29·76	54	35	53	38	53	40	48·5	NE.	SE.	NE.	calm	...	...	...	...	...
27	29·803	29·521	29·94	29·93	29·73	29·66	29·30	56	39	53	39	55	40	41·5	N.	NW.	W.	W.	·15	·09	·060	·050	·05
28	29·715	29·621	29·93	29·90	29·71	29·45	29·05	55	36	55	44	53	38	41	NW.	NW.	NW.	W.	...	·07	...	·075	·25
29	29·900	29·472	30·05	30·00	29·82	29·70	29·23	46	30	49	41	48	33	41·5	NW.	N.	N.	NW.	...	·01	·040	...	·21
30	29·955	29·850	30·05	30·00	29·87	29·82	29·50	47	40	53	41	51	47	42·5	W.	NW.	NW.	NW.	·25	...	·060	·095	·04
Aver.:	30·158	28·978	30·05	28·85	30·00	28·88	29·10	61	29	59	38	65	31	45·7					1·60	4·49	5·500	6·465	3·22

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